MEASUREMENTS OF THE CRANIAL FOSSÆ.

By Aleš Hrdlička,

Assistant Curator, Division of Physical Anthropology, U. S. National Museum.

While there exists only a general correlation between the outside and the inside of the skull, the brain and the cranial cavity correspond under normal conditions exactly. The brain is separated from the skull only by the meninges, which, however, are of small and uniform thickness, and adhere everywhere closely to the organ as well as to the bone, so that the above statement is not affected.

The skull cavity presents certain subdivisions, known as cranial fossæ, which correspond with certain portions of the brain. These fossæ are termed the anterior, middle, and posterior, and the parts of the brain they inclose are the anterior, middle, and posterior lobes of the cerebrum, with the cerebellum. The two last named occupy the posterior fossa on each side, one its superior and the other its inferior portion. As the study of the brain is continually gaining in importance, one of the most valuable investigations on this organ would be a series of accurate measurements of its lobes; but the brain is soft, and before it can be measured must be hardened in preservatives. This, in the case of the heavy human brain, is seldom achieved without some flattening or other deformation. Measurements on a deformed organ can, however, never be accurate and can not be relied upon for any finer differentiations. Moreover, normal human brains are not easily obtained, even those of the whites, and in the case of many races, in which the study of the organ is most urgent, the material is extremely limited or wholly wanting. As a good example of this may be cited the North American Indian, whose brain has never yet been properly studied. There are now in the U. S. National Museum just three brains of these people, and all of them are so badly deformed or damaged as to be entirely unsuitable for measurement. Under such circumstances, and in view of the close correspondence of subdivisions of the brain with those of the skull cavity, it becomes desirable to utilize, so far as feasible, measurements on the latter and on its subdivisions. This has been attempted by the author, and the present report is the result of a limited number of the more important measurements.

Proceedings U. S. National Museum, Vol. XXXII—No. 1521.

This paper deals with the absolute and the relative lengths of the cerebral and cerebellar fossæ in man and a series of animals, and with the relation of the length of the different fossæ to the form of the skull.

The detailed objects of the study were the elucidation of how the several fossæ, or rather the parts of the brain which they limit, differ in the various races of mankind, in the two sexes, between the young and adults, between man and other mammals, and, finally, in dolicho- and brachycephaly.

A similar study of the cranial fossæ has not, so far as the writer was able to learn, been as yet attempted. General remarks on the size of the fossæ will be found in Cuvier;[a] Morton[b] measured the capacity of the "anterior" and "posterior" chamber of the skull, Huschke[c] and Aeby[d] the capacity of the frontal and occipital vertebræ, and Giuffrida-Ruggeri[e] that of the cerebellar fossa; finally a number of observers[f] have measured directly the several lobes of the brain; but linear measurements of the fossæ are wanting. Yet these cavities offer stable boundaries for measurements that are less complicated and less subject to the results of variations in the bones themselves than Huschke's or Aeby's capacities.

One of the main reasons why the cranial fossæ have not received more attention in anthropometry was undoubtedly the scarcity of suitable material, i. e., cut skulls, and it was the writer's opportunity in this particular that was the direct cause of his undertaking the measurements. From 1897 to 1903 the writer enjoyed the privilege of examining the great osteological collection in Prof. George S. Huntington's Morphological Museum in the College of Physicians and Surgeons,[g] New York, and to this were added, every year, a fair number of identified skulls, from which the calvarium had been removed for the purpose of brain demonstration. This provided an ample supply of skulls, already cut, of whites and some of negroes, to which, since 1903, it has been possible to add necessary series of Indian, fetal, and animal crania from the collections of the U. S. National Museum. The writer is particularly indebted to the Division of Mammals of the National Museum for the comparative material.

[a] Leçons d'anatomie comparée, 2 ed., Paris, 1837, p. 288.

[b] S. G. Morton, Crania Americana, Philadelphia, 1839, pp. 253–256.

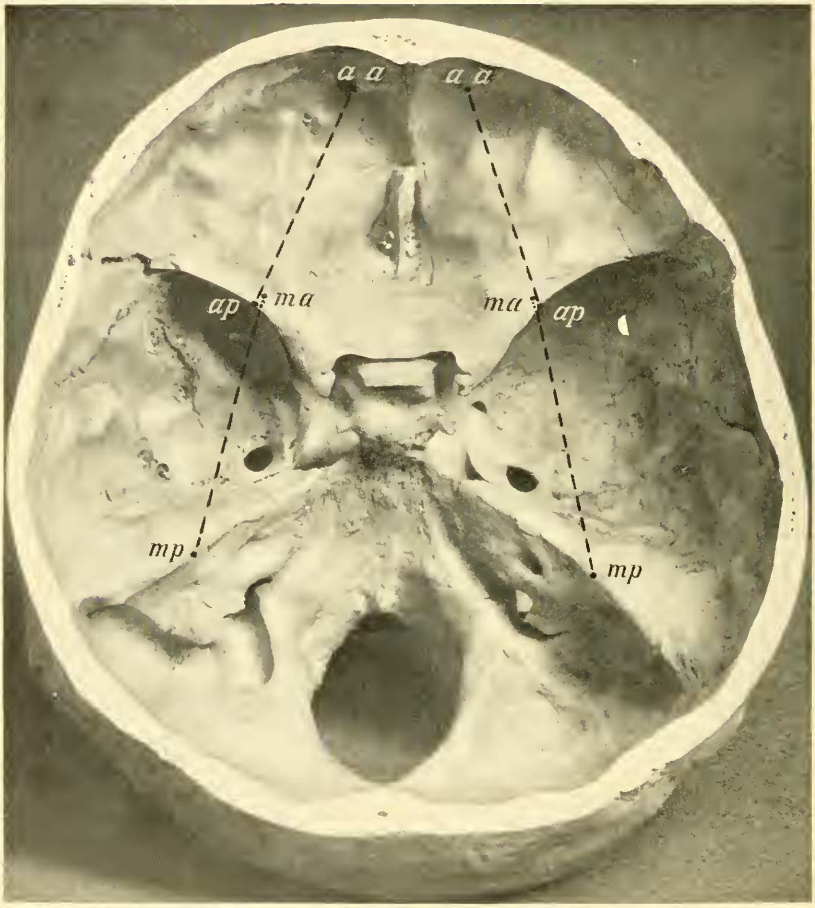
[c] E. Huschke, Schaedel, Hirn und Seele, Jena, 1854, p. 46. (Refers also to C. G. Carus, who compared the three vertebræ—frontal, parietal, and occipital—from measurements obtained between points on the exterior surface of the bones.)

[d] C. Aeby, Beiträge zur Kenntniss der Mikrocephalie, Arch. f. Anthrop., VII, 1874–1875, p. 15.

[e] V. Giuffrida-Ruggeri, La capacità della fossa cerebellare, Sperimentale, XXV 1899, pp. 131-135; also in Arch. ital. de biol., XXXII, 1899, p. 455.

[f] See especially D. J. Cunningham. Address to the Anthropological Section, British Association, Glasgow, 1901, pp. 1–13; also in the Proc. British Association of 1901.

[g] The medical department of the Columbia University.



LANDMARKS AND LINES OF MEASUREMENTS OF THE ANTERIOR AND MIDDLE FOSSAE.

aa, anterior fossa, anterior landmark; *ap*, anterior fossa, posterior landmark; *ma*, middle fossa, anterior landmark; *mp*, middle fossa, posterior landmark.

A long delay in publishing the result of this study was occasioned by lack of anthropoid ape skulls, but even this was eventually supplied from the valuable collection recently sent to the National Museum by Dr. W. L. Abbott.

The total number of specimens measured was as follows:

Skulls of adult males, white:	
Dolichocephals[a]	[b]20
Mesocephals	20
Brachycephals	20
Skulls of adult females, white:	
Dolichocephals	10
Mesocephals	10
Brachycephals	10
Skulls of adult males, Indian:	
Dolichocephals	10
Brachycephals	10
Skulls of adult males, negro,[c] dolicho- to mesocephals	15
Skulls of adult females, negro, dolicho- to mesocephals	10
Skulls of fetuses and children:	
White, brachycephals	10
Negro, brachycephals	10
Negro, dolicho- to mesocephals	20
Skulls of adult anthropoid apes	13
Skulls of adult monkeys and other mammals	10
Total crania measured	198

Considerable difficulty was encountered at the start in the choice of appropriate measurements and the fixing of good landmarks. Repeated trials showed that measurements of height and breadth of the fossæ, though highly desirable, were quite impracticable, and that to a certain extent artificial landmarks would have to be established for the longitudinal dimensions. In searching for such points from which to measure, the writer was guided by the desire of having the measurements on the bones correspond as closely as possible to definite segments or portions of the brain, and the ultimate selection in human adults was as follows:

Anterior fossæ; adults.—The anterior points from which to measure (*aa*, *aa*, Plate XIV), are located on the arc of a circle of 2 cm. radius, with the foramen cæcum as center; and 1.2 cm. laterad of the median line. They correspond closely to the lower limits of the frontal poles.

The posterior points (*ap*, *ap*) are on the free border of the lesser

[a] Dolichocephals: Cephalic index up to 75; mesocephals, 75.1 to 80; brachycephals, above 80.

[b] Some of the crania were partly damaged, so that not all the fossæ could be examined; details will be clearly seen in the final tables.

[c] Including several African blacks; among the American negroes, though all possessed the features of the race, several were probably of mixed blood (white and black).

wing of the sphenoid, 2 cm. laterad from the outer border of each optic foramen (base of the anterior clinoid process).

The line between *aa* and *ap* runs near to the line of the internal orbital sulcus of the brain and follows closely the horizontal plane of the base of the frontal lobe.

Middle fossæ; adults.—The anterior landmarks from which to measure (*ma*, *ma*,) are located at the anterior extremity of a line passing vertically beneath the points *ap*, *ap*. They correspond closely to the point of the maximum forward bulge in the line of the middle fossæ, i. e. to the poles of the temporal lobes of the cerebrum.

The posterior point (*mp*, *mp*) is on the middle of the superior border of the petrous part of each temporal bone (in the middle between the distal end of that border at the temporo-parietal suture and the medial extremity of the petrous wedge). The lines *ma–mp* are suitable representatives of the antero-posterior diameter of the temporal lobes of the brain.

The *posterior fossæ* consist each of a cerebral and a cerebellar portion, both of which were measured. For anterior landmarks of both portions in adults were chosen the points *mp*. For the posterior landmarks of the cerebellar parts of the cavity (*pi*, *pi*, Plate XV) points were selected on the lower ridge of each lateral sinus, 1.5 cm. from the median line, and the posterior points for the measurement of the cerebral part (*ps*, *ps*) are 2.5 cm. vertically above a horizontal line passing through the more superior of the *pi* marks.

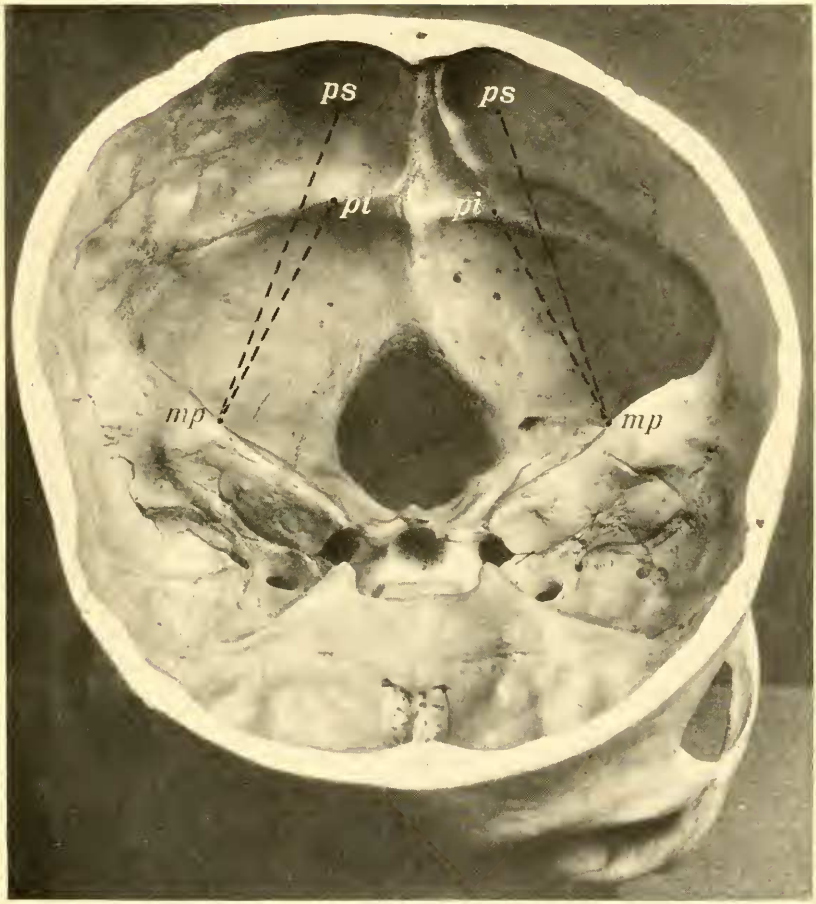
The left inferior ridge of the lateral sinus and hence the left *pi* point is in adult man very often lower than the right. In all such cases it is sufficient for practical purposes to determine the location of the right *ps* point and place the left *ps* horizontally opposite, 1.5 cm. from the median line. The median line is determined by extending the long axis of the foramen magnum.

The *mp–pi* line corresponds to the length of the superior plane of the cerebellum; while the *mp–ps* line measures the length of that part of the cerebrum which lies on the tentorium. The *ps* points correspond quite closely to the occipital poles of the cerebrum.

In the skulls of the human young and of various mammals, the landmarks were virtually the same as in human adults, with the distances between *aa* and *aa* and the points in the posterior fossæ in the smaller skulls diminished proportionately according to the size of the skull.

Several additional measurements besides the foregoing were taken on the ventral parts of the skulls and will be referred to later.

No deformed, pathological, or in any way abnormal skull was included in the series measured, and due care was exercised concerning fortuitous variations affecting the landmarks.



LANDMARKS AND LINES OF MEASUREMENTS OF THE CEREBRAL AND CEREBELLAR PARTS OF THE POSTERIOR FOSSA.

mp, middle fossa, posterior landmark; *ps*, posterior point from which to measure the cerebral part of the posterior fossa; *pi*, posterior point from which to measure the cerebellar part of the posterior fossa.

The instruments used were a small, straight, rigid, sharp-pointed compass; the ordinary anthropometric sliding compass; a compass with sharp-pointed, curved branches, each provided at its middle with an additional joint—an instrument that could be easily converted into an endocompass; and a piece of brass wire 16 cm. long and 2 mm. in diameter, bent in the middle at right angles. This wire served for measuring the middle fossa, the length being marked on it, and read off with the help of the graduated rod of the sliding compass.

To facilitate the presentation of the facts obtained, the measurements of the cerebral fossæ are not only given in absolute figures, but also in their relation to the greatest external and the mean internal antero-posterior diameters of the skull, and to the sum of the lengths of the three cavities. This latter relation, or index, equals with each fossa the length of the fossa multiplied by 100 and the result divided by the sum of the lengths of the 3 cerebral fossæ on same side of the skull.

As to the results of the measurements, it should be constantly borne in mind that they reflect only on the length of the various parts of the brain, and not on other dimensions or mass of these parts, which may be expected to show many additional and perhaps varied features. These can be determined only by extensive measurements on the brain itself.

ANTERIOR FOSSÆ.

The figures that follow give averages of the absolute lengths of the anterior cranial fossæ in the several series of human adults. These data have only a limited value in crude form, except for showing important differences on the two sides of the skull. In this respect it is seen that the average length of the right frontal cavity is greater in every series without exception. This interesting fact, not brought out before, calls for further detailed observations on the brain in this region.

Anterior fossæ: Average length in adults.

Race.	Males.						Females.					
	Dolichocephals.		Mesocephals.		Brachycephals.		Dolichocephals.		Mesocephals.		Brachycephals.	
	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Whites	(14) 53.1	52.3 *a*(−0.8)	(11) 52.2	50.9 *a*(−1.3)	(11) 50.2	49.4 *a*(−0.8)	(5) 48.7	47.8 *a*(−0.9)	(6) 50.5	49.4 *a*(−1.1)	(6) 48.9	48.3 *a*(−0.6)
Indians	(10) 46.9	46.4 *a*(−0.5)	.....	.....	(10) 45.7	45.2 *a*(−0.5)	.....	.....	.....	.....	.....	.....
Negroes	(14) 51.2	50.0 *a*(−1.2)	.....	.....	.....	.....	(5) 51.1	49.2 *a*(−1.9)	.....	.....	.....	.....

a Difference from the right fossa.

There are individual cases in which the fossæ are of equal length or where the left fossa is the longer, but they are small in number in adult skulls and may almost be regarded as exceptions. They occurred as follows:

Length of anterior fossa on the two sides in human adults.

Skulls.	Right anterior fossa longer (per cent of cases).	Anterior fossæ of equal length (per cent of cases).	Left anterior fossa longer (per cent of cases).
14. Adults, whites, males, dolichocephals	64	14	21
12. Adults, whites, males, mesocephals	67	17	17
11. Adults, whites, males, brachycephals	64	18	18
5. Adults, whites, females, dolichocephals	80	20	0
6. Adults, whites, females, mesocephals	83	17	0
6. Adults, whites, females, brachycephals	33	50	16
10. Adults, Indians, males, dolichocephals	60	10	30
10. Adults, Indians, males, brachycephals	60	20	20
14. Adults, negroes, males, dolichocephals	57	29	14
5. Adults, negroes, females, dolichocephals	80	20	0
Totals (93 skulls)	63.5	20.5	16.0

The right anterior fossa, it is seen, exceeds in length the left in 63.5 per cent, or very nearly two-thirds, of adult human skulls, the left exceeding the right in only 16.0 per cent, or approximately one-sixth, of instances.

In the crania of small children and human fetuses, and in those of anthropoid apes and other mammals, the conditions differ from those in human adults, namely:

Length of anterior fossa on the two sides in human fetuses, etc.

Skulls.	Right anterior fossa longer (per cent of cases).	Anterior fossæ of equal length (per cent of cases).	Left anterior fossa longer (per cent of cases).
10 fetuses and children, whites, brachycephals	40	60	0
10 fetuses and children, colored, brachycephals	50	50	0
20 fetuses and children, colored, dolicho and meso cephals	50	45	5
Total (40 skulls)	47.5	50	2.5
2 chimpanzees	100	0	0
1 gorilla	(100)	0	0
6 orangs	50	33	17
4 gibbons	25	25	50
Total (13 skulls)	54	23	23
4 monkeys	25	75	0
1 lemur, 1 bear, 1 deer	[a]33	67	0

[a] The deer.

In human fetuses and children the percentage of cases where the right anterior fossa is longer than the left is decidedly smaller than in human adults, and the same is true of the cases of excess of the left fossa, while the proportion of instances where the two cavities are of the same length is much larger. This shows that although the inequality of the fossæ develops in some cases early, in utero, it does

not develop in quite a large percentage of cases until in later, postnatal life, very likely during the years of the most rapid growth of the brain and the skull. However, even in view of these cases of later development, it is impossible to regard the unevenness of the anterior fossæ, with a pronounced tendency to a moderate excess on the right side, otherwise than as a principal hereditary character.

As further data show, the predominance in length of the right frontal fossa is already well marked in those anthropoid apes that stand nearest to man; and it also occurs occasionally in monkeys and other mammals. It is therefore a rather widely shared and ancient feature.

The actual differences in length of the cavities, while often small, are in some cases very decided as shown in the following table. It may be stated here that none of the small inequalities were included in the lists unless clearly established by the sharp-pointed, straight-branched compass, measurements with which are free from error.

Absolute differences in length of the anterior fossæ; right fossa the longer in cases:

Subjects.	0.5 mm.	1 mm.	1.5 mm.	2 mm.	2.5 mm.	3 mm.	3.5 mm.	4.0 mm.	Above 4 mm.
Human adults	9	14	15	6	1	5	5	1	a3
Human fetuses and young children	6	9	0	4	0	0	0	0	0
Apes	2	2	2	1	0	0	0	0	0
Monkeys and other mammals	1	1	0	0	0	0	0	0	0

Absolute differences in length of the anterior fossæ; left fossa the longer in cases:

Subjects.	0.5 mm.	1 mm.	1.5 mm.	2 mm.	2.5 mm.	3 mm.	3.5 mm.	Above 3.5 mm.
Human adults	3	5	3	1	1	2	1	0
Human fetuses and young children	0	0	1	0	0	0	0	0
Apes	3	0	0	0	0	0	0	0

a1—4.5 mm.; 1=5.5 mm.; 1=7.5 mm.

The inequalities are greater in favor of the right fossa; they are of a smaller and restricted range in the young; they show a fair latitude in the anthropoid apes, but are very small in the lower mammals examined.

Form of skull and race, it was found, are apparently not factors in the development of the differences in length of the two cavities, and the same is probably true of sex. A reference to the detailed tables will also show that among human and anthropoid ape adults there is no regular correspondence between the variation in the relation to each other of the two frontal fossæ and the dimensions of the cranium.

The next point of importance to be cleared is the relation of the mean absolute length of the anterior fossæ to the size of the skull. Are they not only absolutely but also relatively larger in skulls of great size, and the opposite—or is the difference confined only to their abso-

lute proportions? In this instance the fossæ can be advantageously contrasted with the greatest antero-posterior (glabello-occipital) cranial diameter, one of the most familiar of skull measurements.

There are in all 60 skulls (3 series each of 20 specimens) of white males and 30 (3 series each of 10 specimens) of white females. Taking the 9 largest[a] and the 9 smallest (3 of each from each series) of the former and the 6 largest and 6 smallest (2 of each from each series) of the latter group, we find the following conditions as regards the length of the frontal cavities:

Relation of the length of the anterior fossæ to the greatest external length of the skull, in crania of extreme sizes, in whites.

	Males.	Females.
Average relation of the mean length of the two anterior fossæ to the greatest external cranial diameter, the latter being taken as 100, in the largest skulls	26.5	26.7
Extremes	24.5–28.4	25.6–28.6
The same in the smallest skulls	27.1	28.7
Extremes	25.3–28.9	25.8–30.6

The differences are not large, and the detail data showed individual exceptions to be quite numerous; nevertheless both the average values and the extremes plainly indicate a predominance of relatively longer frontal fossæ in the smallest and of relatively shorter frontal cavities in the largest crania.

Very much the same conditions as in whites were found in this regard also among the Indians and the negroes, namely:

Relation of the length of the anterior fossæ to the greatest external length of the skull in crania of extreme sizes in the Indians and negroes.

	Males.	Females.
Average relation of the mean length of the two anterior fossæ to the greatest external cranial diameter in the largest skulls:		
6 Indians (3 of each series)	26.3	.....
3 negroes	26.8	.....
2 negroes	.....	28.2
The same in the smallest skulls:		
6 Indians (3 of each series)	26.5	.....
3 negroes	28.3	.....
2 negroes	.....	28.6

The preceding figures are open to one objection—the external length of the skull, to which lengths of the fossæ were compared, includes two walls of bony tissue, and it is not certain that the proportion of the measurement due to this tissue, known to differ in the sexes and races, is the same with the large as well as the small skulls. The larger this proportion of bony substance the smaller must be the relative length of the fossæ, and the opposite. It was actually found, by comparing the dorsal with the ventral length, that in most of the series the amount of bone entering into the composition of the greatest external antero-posterior diameter of the skull is larger in

[a] The size of the skull being determined by the mean of its greatest length and breadth; height was not obtainable in most cases, but there were no extremes.

the spacious than in the small crania. The comparison of the two diameters, the mean ventral length being taken as 100, was as follows:

Relation between the greater dorsal and mean ventral length of the skull.

Skulls.	No. of specimens.	In the largest skulls.	No. of specimens.	In the smallest skulls.
White males	6	108.5 : 100	6	108.5 : 100
White females	6	109.9 : 100	6	108.5 : 100
Indian males	6	109.2 : 100	6	108.2 : 100
Negroes, both sexes	5	110.6 : 100	5	108.8 : 100

These differences make it necessary to contrast the length of the fossæ in skulls of extreme sizes with the ventral rather than dorsal length of the skull, by doing which the following proportions are obtained (the mean ventral maximum antero-posterior diameter being taken as 100):

Mean length of the anterior fossæ compared with mean ventral length of skull in the largest and smallest adult crania.

Skulls.	Number of specimens.	In the largest skulls.	Number of specimens.	In the smallest skulls.
White males	6 (2 of each series)	28.4	6 (2 of each series)	29.9
White females	do	29.7	do	30.9
Indian males	do	28.8	6 (3 of each series)	28.65
Negroes, both sexes	5 (3 males, 2 females)	30.3	5 (3 males, 2 females)	31.0

The differences are somewhat smaller than when the fossæ were compared with the external cranial length, in all except the white males; but in all of the groups, with the exception of the Indian males, the average of the relative proportions of the frontal cavities in the smallest skulls remains perceptibly above that in the largest specimens. The conclusion before reached of a predominance of relatively longer anterior fossæ in the smallest than in the largest crania is hereby confirmed.

The same interesting fact can also be brought out by contrasting the size of the skull with a number of the largest and smallest relative values of the anterior cavities. This procedure[a] gives the following results in the different groups of adult crania:

9 skulls of white males with the highest relative length[b] of the anterior fossæ.. 16.5
9 skulls of white males with the lowest relative length of the anterior fossæ ... 16.9
6 skulls of white females with the highest relative length of the anterior fossæ. 15.4
6 skulls of white females with the lowest relative length of the anterior fossæ.. 15.8
4 skulls of Indian males with the highest relative length of the anterior fossæ.. 15.5
4 skulls of Indian males with the lowest relative length of the anterior fossæ... 15.9
5 skulls of negroes with the highest relative length of the anterior fossæ..... 15.8
5 skulls of negroes with the lowest relative length of the anterior fossæ 16.1

[a] Represented by the mean of the greatest external length and breadth of the skulls.

[b] That is, the highest relation of the mean length of the two fossæ to the maximum antero-posterior (glabello-occipital) diameter of the skull.

It is seen that throughout, in adults, the relatively longer anterior fossæ correspond to smaller skulls, and the opposite. The Indian and negro, and the sex, are no exception; apparently the phenomenon is general in the whole human family. Individual cases not agreeing with the rule were met with in all the groups, but were not very numerous. The immediate cause of the condition, upon which more light will be thrown in later paragraphs, can only be a slightly less capacity, or rather necessity, of growth in length of the frontal fossæ than that of growth in length of the rest of the cranium. This can in all probability be applied also to the growth of the frontal lobes of the cerebrum, an indication of a relatively greater expansion of the other portions of the organ, containing the motor and sensory areas, in the course of development.

It remains to consider the proportions of the anterior fossæ in adults and young, men and animals, sexes, races, and different cranial forms. For these purposes the mean length of the two fossæ may be compared again with the greatest external cranial diameter. The following table presents in a succinct form the results. Only those skulls are here included in which both fossæ could be measured, which removes some possible causes of error.

Length proportions of anterior fossæ in relation to greatest external length of the skull.

Subjects.	Number of skulls.	Average external maximum length of skull.	Average mean length of the 2 anterior fossæ.	Average relation of the length of the fossæ to the dorsal length of the skull, and extremes.
Adults:				
Whites, males—		*cm.*	*mm.*	
Dolichocephals	14	19.4	52.7	27.2 (25.3–28.8)
Mesocephals	11	18.7	51.5	27.5 (24.3–30.2)
Brachycephals	11	18.2	49.8	27.3 (24.5–30.9)
Whites, females—				
Dolichocephals	5	17.8	48.2	27.1 (24.6–30.6)
Mesocephals	6	17.8	49.7	28.1 (26.1–30–6)
Brachycephals	6	17.3	48.6	28.2 (25.6–31.2)
Indians, males—				
Dolichocephals	10	18.3	46.6	25.5 (22.7–29.6)
Brachycephals	10	16.9	45.4	26.8 (24.4–28.5)
Negroes—				
Males, dolicho- and mesocephals	14	18.6	50.6	27.3 (25.3–30.7)
Females, dolicho-and mesocephals	5	17.7	50.1	28.3 (26.2–30.2)
Fetuses and young:				
White fetuses and children, brachycephals	10	.....	.....	31.1 (28.6–35.0)
Colored fetuses and children:				
Brachycephals	10	.....	.....	30.9 (27.5–35.7)
Dolicho-and mesocephals	20	.....	.....	30.6 (26.1–35.6)
Anthropoid apes:				
Chimpanzees	2	11.9	39.0	32.9 (31.4–34.0)
Orangs	6	11.0	36.2	30.4 (28.2–32.8)
Gibbons	4	7.5	27.3	36.2 (35.0–37.3)
Monkeys and lemurs:				
Macacus pelops	1	8.2	29.5	36.0
Cebus hypoleucus	1	7.5	23.2	30.0
Alouata senicula	1	7.0	23.0	32.9
Midas	1	4.1	13.0	31.7
Lemur varius	1	6.0	22.0	36.7

The above data certainly reveal interesting conditions.

The relative length of the anterior fossæ is in general decidedly greater in fetuses and young than in adults; the antero-posterior

development of the frontal cavities, therefore, lags behind the development of the rest of the skull in the same direction throughout growth. This harmonizes well with the relatively small frontal fossæ in many of the largest adult crania. A remarkable diminution in the relative length of the anterior fossæ takes place during fetal growth itself. Thus, in the six smallest fetuses and the six largest children,[a] the mean lengths of the fossæ were toward the greatest external length of the skull, respectively as 32.9 (28.6–35.0) and 30.1 (28.0–33.1) to 100. Individual variation is quite pronounced at all stages of life.

The differences, in man and lower mammals, between the length of the anterior fossæ as related to the greatest external length of the skull are much like those between human adults and young. In all the species of animals examined, the anthropoid apes included, the relative length of the frontal cavities is greater than that in human adults; in a few instances it is even greater than in the human young. If the anterior lobes of the brain correspond in dimensions to the anterior fossæ, as we believe, the facts shown by the figures relating to the young, and especially to the other mammals than man, mean a striking change in our notions concerning the relative size of those parts of the cerebrum in the beings involved. There are differences between the various species of anthropoid apes and monkeys, but from the small number of specimens it is impossible to conclude how far these differences are characteristic of definite groups.

As to sexes, the females, both among the whites and negroes, show on the whole, relatively longer anterior fossæ than the males. This difference is not large and agrees with the smaller size of the female skull. The female sex appears in this, as in so many other features, slightly nearer the infantile conditions.

The racial differences in the frontal cavities are of a peculiar nature. In whites and negroes the relative proportions of the anterior fossæ, as contrasted with the length of the skull, are practically alike, but in the Indian they are decidedly smaller. The latter condition is not due to a large development of the Indian skulls; in fact these are smaller than either those of the whites or those of the negroes of the same sex.

There are certain differences in the relative length of the anterior fossæ between dolichocephalic and brachycephalic crania, the proportion being in all the groups slightly higher in average in the latter than in the former. No clear reason for this has been arrived at. The series overlap to a considerable extent through individual irregularities.

The familiar greatest antero-posterior (glabello-occipital) diameter has proved very serviceable for contrasting the dimensions of the

[a] For sizes see detailed tables at the end of the paper. Only one of the children reached as high as about the sixth year of age. All the others were much younger.

anterior fossæ, but certain objections, valid and partly shown before, are liable to be raised against it.[a] It is therefore advisable to contrast the length of the cavities in all the series also with the mean ventral diameter of the crania.[b] The next table gives the relations of the mean of the two frontal fossæ with the mean ventral length of the skulls in all the groups dealt with in the preceding list, and it will be seen that, though the figures differ a little, the results are substantially identical.

Mean length of the anterior cranial fossæ in relation to the mean of the right and left greatest ventral diameters of the skull.

Subjects.	Number of skulls.	Average relation of the fossæ (mean ventral length =100).	Average relation of the fossæ (greatest external length= 100).	Number of skulls.
Adults:				
Whites, males—				
Dolichocephals	6	29.3	27.2	14
Mesocephals	9	29.5	27.5	11
Brachycephals	8	29.6	27.3	11
Whites, females—				
Dolichocephals	5	29.4	27.1	5
Mesocephals	6	30.4	28.1	6
Brachycephals	4	30.0	28.2	6
Indians, males—				
Dolichocephals	10	28.0	25.5	10
Brachycephals	10	29.5	26.8	10
Negroes—				
Males, dolicho- and mesocephals	13	30.4	27.3	14
Females, dolicho- and mesocephals	4	31.0	28.3	5
Fetuses and young:				
White fetuses and children, brachycephals	9	33.1	31.1	10
Colored fetuses and children, brachycephals	10	32.2	30.9	10
Dolicho- and mesocephals	20	32.3	30.6	20
Anthropoid apes:				
Chimpanzees	2	35.3	32.9	2
Orangs	6	34.4	30.4	6
Gibbons	4	37.5	36.2	4
Monkeys and lemurs:				
Macacus pelops	1	38.3	36.0	1
Cebus hypoleucus	1	34.7	30.0	1
Alouata senicula	1	39.1	32.9	1
Midas	1	33.1	31.7	1
Lemur varius				
Other mammals:	1	41.5	36.7	1
Ursus americanus	1	38.4	.....	.....
Deer	1	34.1	.....	.....

The position of the Indian is seen in this table in a clearer light, and the same is true of the negro, the former appearing nearer to the white man and the latter nearer to less developed forms of crania. The exceptional position of the gibbons among the anthropoid apes, and of the macaque, alouata, and lemur in the following group, remains accentuated.

The correlation of the anterior with the other fossæ of the skull will be treated of later on.

[a] Varying dimensions of the glabella and occipital ridges; the point chosen in apes instead of glabella; the varying thickness of bone included.

[b] Average of the greatest internal length of the right and left side.

MIDDLE FOSSÆ.

The absolute average length of the middle fossæ in human adults shows as follows:

Middle fossæ: Average length in adults.

Race.	Males.						Females.					
	Dolichocephals.		Mesocephals.		Brachycephals.		Dolichocephals.		Mesocephals.		Brachycephals.	
	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Whites	(14) 54.9	54.8 (*a*−0.1)	(11) 55.3	55.1 (*a*−0.2)	(11) 55.4	56.5 (*a*+1.1)	(5) 51.3	50.7 (*a*−0.6)	(6) 52.7	52.1 (*a*−0.6)	(6) 51.4	51.4 (*a*+−0)
Indians	(10) 53.3	51.8 (*a*−1.5)	.....	.....	(10) 53.6	51.9 (*a*−1.7)	.....	.....	.....	.....	.....	.....
Negroes	(14) 53.4	53.5 (*a*+0.1)	.....	.....	.....	.....	(5) 49.8	49.6 (*a*−0.2)	.....	.....	.....	.....

a Differences from the right fossa.

The cavities, it is seen, are slightly longer than the anterior ones (in the proportion of 108 to 100—a detailed comparison in a future paragraph). There is again a predominance in the length of the right fossa, but it is not as great or equally frequent as in the case of the anterior fossæ.

Length of middle fossa on the two sides in human adults.

Skulls.	Right middle fossa longer (per cent of cases).	Middle fossæ of equal length (per cent of cases).	Left middle fossa longer (per cent of cases).
16 adults, whites, males, dolichocephals	31	37	31
14 adults, whites, males, mesocephals	43	21	36
15 adults, whites, males, brachycephals	40	33	27
8 adults, whites, females, dolichocephals	50	12	37
7 adults, whites, females, mesocephals	43	29	29
6 adults, whites, females, brachycephals	33	50	17
10 adults, Indians, males, dolichocephals	70	20	10
10 adults, Indians, males, brachycephals	50	40	10
15 adults, Negroes, males, dolichocephals	47	27	27
9 adults, Negroes, females, dolichocephals	33	22	44
Total (110 skulls)	44	29	27

With the anterior fossæ the conditions were: Right longer, 63.5; equal, 20.5; and left longer, 16 per cent.

In the skulls of the fetuses and young, and in those of anthropoid apes and other mammals, the results differ from those in human adults. There were among:

Length of middle fossa on the two sides in human fetuses, etc.

Skulls.	The right middle fossa longer.	Middle fossæ equal.	The left middle fossa longer.
	Per cent.	*Per cent.*	*Per cent.*
40 human fetuses and young	35	50	15
13 anthropoid apes	69	23	8
7 other mammals	29	43	29

These figures show again, as did similar data with the anterior fossæ (q. v.), that in the fetuses and young the proportion of cases where either the right or the left cavity is longer is much smaller than in the adults, and points to the fact that irregularities are to a large extent of later development. In the anthropoid apes I find a higher differentiation in the middle fossæ than in the human young, similarly as with the anterior cavities.

The actual differences between the middle fossæ ranged thus:

Absolute differences in length of the middle fossæ; right fossa the longer in cases:

Subjects.	0.5 mm.	1 mm.	1.5 mm.	2 mm.	2.5 mm.	3 mm.	3.5 mm.	4 mm.	Above 4 mm.
Human adults	5	17	6	11	3	3	1	1	[a]1
Human fetuses and young	1	9	2	2	0	0	0	0	0
Anthropoid apes	3	4	0	1	1	0	0	0	0
Monkeys and other mammals	1	1	0	0	0	0	0	0	0

[a] 6.5 mm.

Absolute differences in length of the middle fossæ; left fossa the longer in cases:

Subjects.	0.5mm.	1 mm.	1.5mm.	2 mm.	2.5mm.	3 mm.	3.5mm.	4 mm.	Above 4 mm.
Human adults	3	11	2	5	1	3	2	2	[a]1
Human fetuses and young	2	4	0	0	0	0	0	0	0
Anthropoid apes	0	1	0	0	0	0	0	0	0
Monkeys and other mammals	1	1	0	0	0	0	0	0	0

[a] 5.5 mm.

The conditions disclosed by the above figures are such that almost the exact words which were used in describing the differences in the anterior fossæ are applicable. In this case, as there, the range of differences is somewhat greater with the right fossa; the inequalities are smaller in the young; they show a range of fair extent in the anthropoid apes, though the skulls are less than half the size of full-grown human crania, and they are very small in the monkeys and other mammals.

The form of the skull may have some slight connection in this case with the differences in the length of the cavities. In three of the series (white females, Indians, negroes) the right fossa is longer than the left in a larger percentage of the dolichocephals than of the brachycephals (in dolichocephals in 50, 70, 47 per cent; in brachycephals, respectively, in 33, 50, and 33 per cent of cases). Race may also be a factor, for a larger proportion of cases with longer right middle fossa is found among the Indians than in any of the other series. As to sex, no influence on the difference between the lengths of the two middle cavities is apparent.

A comparison of the inequalities in length in the middle with those of the anterior fossæ reveals the fact that these disproportions can be

only in a limited number of cases compensatory in nature; in a large percentage of the crania there is no trace of a correlation. The following conditions exist in this regard among the human adults:

	Per cent of cases.
Anterior fossæ of equal length, middle fossæ of equal length	4.3
Anterior fossæ of equal length, right middle fossa longer than left	10.9
Anterior fossæ of equal length, right middle fossa shorter than left	5.4
Right anterior fossa longer than left—	
middle fossæ equal	20.7
right middle fossa longer than left	29.3
right middle fossa shorter than left	13.0
Right anterior fossa shorter than left—	
middle fossæ equal	4.3
right middle fossa longer than left	8.7
right middle fossa shorter than left	3.3

The only two series of cases where a compensation between the length of the anterior and middle fossa of the same side may exisit (that is, "the right anterior fossa longer than the left—the right middle fossa shorter than the left," and the opposite) embrace only 13 and 8.7, in total 21.7 per cent, or about one-fifth of all the skulls examined. On the other hand, a greater length of both the anterior and middle fossa on the same side was present in 29.3 per cent (right side) and 3.3 per cent (left side), in all 32.6 per cent, or almost one-third, of the crania. These facts show that the dimensions of one pair of the fossæ in question are to a large extent independent of those of the other pair, which make it plain that they are not due to conditions inherent in the bones themselves, but to those pertaining to the brain.

The relations which the mean length of the two middle fossæ bear to the size of the skull are indicated in the figures below. As with the anterior cavities, the size of the skull was judged from the mean of its greatest length and breadth; the fossæ were contrasted with the greatest external as well as the mean ventral length. The specimens selected for this comparison were the same as with the frontal fossæ on a similar occasion.

Average relations of the mean length of the two middle fossæ to the greatest dorsal and mean ventral length of the skull (each of these diameters being each taken as 100), in the largest and smallest skulls of the series.

Subject.	Number of specimens.	In the largest crania—		Number of specimens.	In the smallest crania—	
		vs. external length.	*vs.* internal length.		*vs.* external length.	*vs.* internal length.
Adults:						
White males	6 (2 of each series)	28.9	31.2	6 (2 of each series)	27.5	29.9
White females	6 (2 of each series)	27.7	30.4	6 (2 of each series)	29.6	32.3
Indian males	6 (3 of each series)	26.3	28.8	6 (3 of each series)	26.5	28.6
Negroes, both sexes	5 (3 males, 2 females)	27.4	30.3	5 (3 males, 2 females)	28.5	31.0

The conditions are irregular. The length of the middle fossæ in the smallest skulls exceeds that in the largest specimens among the white males and in the negroes; in the white females the facts are the reverse; while in the Indians the differences are immaterial. Much larger numbers of cases would probably clear up the matter; as it is, it is necessary to reserve conclusions.

The differences in the absolute and relative length proportions of the middle fossæ between adults and young, in man and animals, in the sexes, in races, and various forms of the skull, are contrasted in the table that follows:

Length proportions of middle fossæ in relation to greatest external length of the skull.

Subjects.	Number of skulls.	Average dorsal maximum length of skull.	Average mean length of the two middle fossæ.	Average relation of the length of the fossæ to the dorsal length of the skull.	Average relation of the length of the fossæ to the ventral length of the skull.	Number of skulls.
Adults:						
White males—		*cm.*	*mm.*			
Dolichocephals	14	19.4	54.9	28.3	31.9	10
Mesocephals	11	18.7	55.2	29.4	32.2	14
Brachycephals	11	18.2	55.9	30.7	33.9	10
White females—						
Dolichocephals	5	17.8	51.0	28.6	31.4	10
Mesocephals	6	17.8	52.4	29.5	33.0	9
Brachycephals	6	17.3	51.4	29.8	32.0	5
Indian males—						
Dolichocephals	10	18.3	52.5	28.7	31.5	10
Brachycephals	10	16.9	52.7	31.2	34.3	10
Negroes—						
Males, dolicho- and mesocephals	14	18.6	53.5	28.8	31.9	13
Females, dolicho- and mesocephals	5	17.7	49.7	28.1	31.1	8
Fetuses and young	40	9.1	26.2	28.8	30.2	39
White, brachycephals	10	7.9	24.4	30.7	32.1	9
Colored, brachycephals	10	9.2	26.6	28.9	30.1	10
Colored, dolicho- and mesocephals	20	9.7	26.9	27.8	29.3	20
Anthropoid apes:						
Chimpanzees	2	11.9	38.5	32.3	34.8	2
Orangs	6	11.9	37.1	31.1	35.3	6
Gibbons	4	7.5	24.2	32.0	33.2	4
Monkeys and lemurs:						
Macacus pelops	1	8.2	28.5	34.7	37.0	1
Cebus hypoleucus	1	7.5	24.0	32.0	35.8	1
Alouata senicula	1	7.0	25.7	36.8	43.8	1
Midas	1	4.1	15.2	37.2	38.8	1
Lemur varius	1	6.0	22.5	37.5	42.4	1

Contrary to what was witnessed with the frontal fossæ, the middle cavities in the human young (particularly in the dolicho- and mesocephalic colored fetuses) show somewhat smaller relative proportions than in the adults. The increase in their relative value within the series, from the smallest to the largest fetuses, is very irregular.

In anthropoid apes the middle fossæ are relatively slightly longer, in the monkeys and lemurs decidedly longer, than in any of the human series. They differ most widely in this from the human young.

In sexes the relative proportions of the middle cavities differ quite immaterially. Neither are there any great racial differences, though

it should be noted that the Indian male brachycephals show the maximum and the negro dolichocephals the minimum proportions.

There are, however, even more so than with the frontal cavities (q. v.), differences of the relative length of the middle fossæ in the different forms of the skull, this length being throughout smaller in the dolichocephals than in the brachycephals, while with the mesocephals it is mostly intermediary. Even in the young the proportions are higher in the short than in the long crania. The differences regarding the frontal fossæ were, it will be remembered, of a like nature, though seemingly of different morphological significance.

The correlation of the middle with the other fossæ will be dealt with in a future section.

POSTERIOR FOSSÆ: CEREBRAL PORTION.

The absolute lengths of these fossæ are as indicated in the figures that follow. In the three upper lines of the table are represented only those skulls in which also all the other fossæ could be measured, that is, skulls which correspond to those given in tables of absolute measurements of the middle and frontal cavities; while in the fourth line are the lengths of all the pairs of the postero-superior fossæ in the skulls examined. The two lines of figures show no great difference.

Posterior fossæ, cerebral part: Average length in adults.

Race.	Males.						Females.					
	Dolichocephals.		Mesocephals.		Brachycephals.		Dolichocephals.		Mesocephals.		Brachycephals.	
	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Whites	(14) 81.0	83.2 *a*(+2.2)	(11) 79.6	81.8 *a*(+2.2)	(11) 75.9	78.7 *a*(+2.8)	(5) 74.0	77.8 *a*(+3.8)	(6) 75.8	78.1 *a*(+2.3)	(6) 75.0	75.6 *a*(+0.6)
Indians	(10) 79.2	82.4 *a*(+3.2)	.....	.....	(10) 73.5	74.1 *a*(+0.6	.....	.....	.....	.....	.....	.....
Negroes	(14) 77.3	80.2 *a*(+2.9)	.....	.....	.....	.....	(5) 74.4	76.6 *a*(+2.2)	.....	.....	.....	.....
Whites, all skulls in which the two fossæ could be measured	(20) 80.5	81.7 *a*(+1.2)	(19) 78.3	80.4 *a*(+2.1)	(19) 76.3	78.8 *a*(+1.5)	(10) 73.8	76.8 *a*(+3.0)	(9) 76.0	78.7 *a*(+2.7)	(9) 73.6	75.7 *a*(+2.1)

a Difference from the right fossa.

The most striking feature of the above data is the evidence that in all the groups and series the left fossa is the longer, which is the reverse of what was observed with the middle and especially with the

anterior cavities; and the differences are in most cases very decided. Individually, the cases where the left fossa is not the longer are in nearly all the series comparatively infrequent, namely:

Length of postero-superior fossa on the two sides in human adults.

Skulls.	Right postero-superior fossa longer (per cent of cases).	Fossæ equal (per cent of cases).	Left postero-superior fossa longer (per cent of cases).
Adults:			
Whites, males—			
Dolichocephals	20	15	65
Mesocephals	21	11	68
Brachycephals	0	11	89
Whites, females—			
Dolichocephals	20	0	80
Mesocephals	11	11	78
Brachycephals	25	12	63
Indians, males—			
Dolichocephals	20	0	80
Brachycephals	50	0	50
Negroes—			
Males, dolichocephals	20	0	80
Females, dolicho- and mesocephals	40	0	60

The left fossa is shown to be the longer in from 50 to 90 per cent of the cases in the various series, or in over 72 per cent, or nearly three-fourths of the crania, if we take all the 130 skulls together. The middle fossæ, it was seen, showed in 44 per cent, and the anterior cavities in 63.5 per cent, an excess in the length on the right side.

Among the human young and the anthropoid apes, and in other mammals, the conditions were as follows:

Length of postero-superior fossa on the two sides in human fetuses, etc.

Skulls.	Right postero-superior fossa longer.	Fossæ equal.	Left postero-superior fossa longer.
	Per cent.	*Per cent.*	*Per cent.*
40 human fetuses and young	17	45	37
13 anthropoid apes	15	23	62
7 monkeys and other mammals	43	14	43

In the human young there is a much larger percentage than in adults of postero-superior fossæ of equal length, showing again, as with the middle and anterior cavities, that the inequalities are often of later development. In the present case this seems to be true particularly of the excess of length on the left side. In the anthropoid apes the conditions are not much different from those in human adults, which indicates that the predominance of excess of length in the left postero-superior fossa, and of that portion of the cerebrum which enters into it, is an ancient feature which has not been acquired and has scarcely been modified in man. Among monkeys and lower mammals there seems to be less regularity in the unevenness of the postero-superior

cavities, but the number of cases is not sufficient for any definite conclusion.

The absolute difference in the length of the two postero-superior fossæ is often very pronounced, much more so than in the case of the frontal and middle cavities. It ranged as follows:

Absolute differences in length of the postero-superior fossæ; right fossa the longer in cases:

Subjects.	0.5 mm.	1.0 mm.	1.5 mm.	2.0 mm.	2.5 mm.	3.0 mm.	3.5 mm.	4.0 mm.	4.5 mm.	5.0 mm.	5.5 mm.	6.0 mm.	6.5 mm.	7.0 mm.	Over7 mm.
Human adults	5	6	4	4	0	3	1	1	0	2	6	1	0	0	*a* 2
Human fetuses and young	1	5	0	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Anthropoid apes	0	1	0	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Monkeys and other mammals	1	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Adsolute differences in length of the postero-superior fossæ; right fossa the longer in cases:

Subjects.	0.5 mm	1.0 mm.	1.5 mm.	2.0 mm.	2.5 mm.	3.0 mm.	3.5 mm.	4.0 mm.	4.5 mm.	5.0 mm.	5.5 mm.	6.0 mm.	6.5 mm	7.0 mm.	Over7 mm.
Human adults	0	14	7	7	12	5	6	12	3	4	10	5	3	2	*b* 2
Human fetuses and young	2	5	1	5	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....
Anthropoid apes	0	1	2	1	1	2	1	.....	.....	.....	.....	.....	.....	.....	.....
Monkeys and other mammals	0	1	0	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

a 8 mm. *b* 1 of 8.5 mm.; 1 of 11 mm.

In 25 subjects, it is seen, the inequality in the length of the two fossæ exceeded half a centimeter, and in one it reached 11 millimeters.

Those figures of the preceding table that concern human adults can be more conveniently expressed in percentages, thus:

Posterior superior fossæ longer by—

0.5 to 2.0 mm., right in 65.5 per cent, left in 30.4 per cent of cases.
2.5 to 4.0 mm., right in 17.2 per cent, left in 38.0 per cent of cases.
4.5 to 6.0 mm., right in 10.3 per cent, left in 24.0 per cent of cases.
Above 6.0 mm., right in 6.9 per cent, left in 7.6 per cent of cases.

The above brings out clearly a predominance of the minor differences in that category of cases where the right fossa is longer, and of the greater inequalities in the larger class of cases where the left fossa exceeds in length. Similar conditions were noticed with the middle and the anterior cavities; on the side (in both these instances the right) where there was a prevalence of longer fossæ, there were also noticed greater actual differences in length from the opposite cavity, and the reverse.

The influences on the length of the two postero-superior fossæ of skull-form, sex, and race are not clearly defined; the question might possibly be settled by much larger series of skulls.

A comparison of the length of the postero-superior fossæ with the combined length of the middle and anterior cavities shows that frequently the greater length of one of the former stands in what is in

all probability compensatory relation with the latter. The following conditions existed in this regard among the human adults.

	Per cent of cases.
Anterior (*a*) + middle (*m*) fossæ of equal length, postero-superior (*ps*) fossæ of equal length	0
a+*m* of equal length, right *ps* longer than left	1.1
a+*m* of equal length, right *ps* shorter than left	7.6
Right *a* + *m* longer than left, *ps* equal	2.2
Right *a* + *m* longer than left, right *ps* longer than left	12.0
Right *a* + *m* longer than left, right *ps* shorter than left	56.5
Right *a* + *m* shorter than left, *ps* equal	4.3
Right *a* + *m* shorter than left, right *ps* longer than left	6.5
Right *a* + *m* shorter than left, right *ps* shorter than left	9.8

In 63 (56 + 6.5) per cent of the cases the length of the postero-superior fossa stood in an apparently compensatory relation to the joint length of the two other cavities of the same side. A certain proportion of this number of cases, very probably the majority, represents a true compensation, the rest being due to conditions inherent in the posterior fossæ themselves or, more properly, in peculiarities of those portions of the cerebrum which fill them. In 21.8 (right 12, left 9.8) per cent of the skulls the postero-superior fossa on one side was longer, notwithstanding the fact that the sum of the length of the middle and anterior cavities on the same side was also longer than that on the opposite side. In several of these cases all the three cavities on the same side were individually longer than those on the other side of the same skull. In no case among the 92 adult human crania were all the three fossæ of one side exactly equal to those opposite. The tendency to a greater length of the left postero-superior fossa is very pronounced. It accompanies, in the skull, and is the main manifestation of, the prevalent greater length of the left cerebral hemisphere.

The relations born by the mean length of the postero-superior fossæ to the size of the skull, the latter judged as before, from the mean of its greatest length and breadth, are indicated beneath, the specimens represented being the same as with the frontal and middle fossæ on the occasion of similar comparison.

Average relation of the mean length of the two postero-superior fossæ to the greatest dorsal and mean ventral length of the skull (each of these diameters being taken as 100) in the largest and smallest skulls of the series.

Skulls.	In the largest crania.			In the smallest crania.		
	No. of specimens.	*ps.* external length.	*ps.* internal length.	No. of specimens.	*ps.* external length.	*ps.* internal length.
Adults:						
White males	6	43.2	46.9	6	43.1	46.8
White females	6	42.9	47.2	6	43.0	46.7
Indian males	6	43.8	47.9	6	43.7	47.3
Negroes, both sexes	5	41.7	46.2	5	44.0	47.9

No regular or substantial difference is apparent. There is no compensation in this regard between the postero-superior and the anterior cavities, which latter, it will be remembered, are relatively shorter in the largest than in the smallest crania.

The absolute and relative length proportions of the postero-superior fossæ, contrasted between adults and young, man and animals, sexes, races, and in the main cranial forms, are presented in the following table:

Length proportions of postero-superior fossæ in relation to greatest external length of the skull.

Subjects.	Number of skulls.	Average external maximum length of skull.	Average mean length of the two postero-superior fossæ.	Average relation of the length of the fossæ to the dorsal length of the skull.	Average relation of the length of the fossæ to the ventral length of the skull.	Number of skulls.
		cm.	*mm.*			
Adults:						
Whites, males—						
Dolichocephals	14	19.4	82.1	42.4	45.9	10
Mesocephals	11	18.7	80.7	43.0	46.0	14
Brachycephals	11	18.2	77.3	42.4	46.4	10
Whites, females—						
Dolichocephals	5	17.8	75.9	42.6	45.8	10
Mesocephals	6	17.8	76.9	43.3	46.8	9
Brachycephals	6	17.3	75.3	43.5	47.4	5
Indians, males—						
Dolichocephals	10	18.3	80.8	44.2	48.5	10
Brachycephals	10	16.9	73.8	43.6	48.0	10
Negroes—						
Males, dolicho- and mesocephals	14	18.6	78.7	42.4	46.7	13
Females, dolicho- and mesocephals	5	17.7	75.5	42.7	46.9	8
Human fetuses and young	40	9.1	41.1	44.5	46.9	39
Anthropoid apes:						
Chimpanzees	2	11.9	49.8	41.7	45.0	2
Orangs	6	11.9	51.0	42.8	48.5	6
Gibbons	4	7.5	30.8	40.7	42.3	4
Monkeys and lemurs:						
Macacus pelops	1	8.2	32.5	39.6	42.2	1
Cebus hypoleucus	1	7.5	28.0	37.3	41.8	1
Alouata seniculu	1	7.0	24.5	35.0	41.7	1
Midas	1	4.1	16.5	40.2	42.0	1
Lemur varius	1	6.0	17.3	28.7	32.5	1

The average relative proportions of the postero-superior cavities differ, it is seen, but little between human adults and the young; taken as a whole, the middle fossæ presented a moderate, the frontal cavities a marked, diversity at the two periods of life. If we compare the relative proportions of the postero-superior fossæ in the smallest fetuses of the series, namely, in those where the vertex-breech length was less than 20 cm. with those where it was above that, we find somewhat different conditions, as shown in the following table:

Case.	Vertex-breech length in centimeters.	Relation of the mean length of the postero-superior fossæ to the—	
		dorsal length of the skull.	mean ventral length of the skull.
1	5.2	33.3	42.4
2	8.3	41.7	47.2
3	15.9	37.6	40.4
4	17.4	40.6	44.8
5	17.6	37.6	40.9
6	19.9	44.7	45.4

The relation to the dorsal length of the skull is in these cases probably the more reliable, as the ventral length can easily and imperceptibly be augmented a little by the relaxation of the bones consequent upon the removal of the parietals, which constituted the method of opening the small skulls. However, compared to either the external or internal cranial length, the fossæ are in the majority of the cases shown to be smaller than during later development. In fetuses in which the vertex-breech length is above 20 cm. the relative dimensions of the fossæ are much more like those in adults, showing that the attainment of their full relative length takes place very early.

In anthropoid apes, monkeys, and lemur, with the sole exception of the orang, the postero-superior cavities are relatively shorter than in human adults, agreeing in this respect with what exists in the earlier stages of fetal life in man. The proportions are particularly low in the lemur.

No definite difference in the relative length of the postero-superior cavities appears in the sexes. Among races, they are longest in the Indian, the whites and negroes being near alike. As to the main cranial forms, among whites the fossæ are in both sexes in the average slightly longer in the meso- than in the dolichocephals, and still longer in the brachycephals, while among the Indians and the young it is the fossæ in the dolichocephals that are slightly longer. The differences in this respect are, however, throughout too small to be of much significance; besides, individual exceptions are numerous in all the series.

THE THREE CEREBRAL FOSSÆ CONSIDERED TOGETHER.

The sum of the lengths of the three cerebral fossæ on each side shows this interesting distribution:

Sum of lengths of cerebral fossæ.

Subjects.	No. of cases.	*a*+*m*+*ps*.	
		Right side.	Left side.
		cm.	*cm.*
Whites, males:			
Dolichocephals	14	18.9	19.0
Mesocephals	11	18.7	18.8
Brachycephals	11	18.1	18.4
Whites, females:			
Dolichocephals	5	17.4	17.6
Mesocephals	6	17.9	18.0
Brachycephals	6	17.5	17.5
Indians, males:			
Dolichocephals	10	17.9	18.1
Brachycephals	10	17.3	17.1
Negroes, males:			
Dolicho- and mesocephals	14	18.2	18.4
Negroes, females:			
Dolicho- and mesocephals	5	17.5	17.5
Human fetuses and young	40	9.55	9.5
Anthropoid apes	13	11.3	11.3
Monkeys and lemur	5	6.9	6.9

[*a*, anterior; *m*, middle; *ps*, postero-superior fossa.]

In seven of the ten series of human adults the average of the sum of the lengths of the three cerebral fossæ on the left exceeds that of the right side by from 1 to 3 millimeters. There is therefore a clear, though small, excess of fossal length on the left in the mass of human adult crania. In two series the averages are equal; while in one series, the brachycephalic Indians, an excess (2 mm.) is shown for the right side. In the human young, anthropoid apes, and monkeys, the difference in the averages are nil, or not exceeding half a millimeter.

Individually the sum of the lengths of the three fossæ on each side was as follows:

Combined length of cerebral fossæ on the two sides.

Subjects.	Right $a+m+ps$ longer than left in—	Equal in—	Left $a+m+ps$ longer than right in—
	Per cent.	*Per cent.*	*Per cent.*
Whites, males:			
Dolichocephals	14	21	64
Mesocephals	36	0	64
Brachycephals	45	0	55
Whites, females:			
Dolichocephals	0	20	80
Mesocephals	33	0	66
Brachycephals	50	17	33
Indians, males:			
Dolichocephals	30	0	70
Brachycephals	60	20	20
Negroes, males:			
Dolicho- to mesocephals	21	14	64
Negroes, females:			
Dolicho- to mesocephals	40	0	60
Human fetuses and young	50	25	25
Anthropoid apes	46	23	31
Monkeys and lemur	50	17	33

[a, anterior; m, middle; ps, postero-superior fossa.]

These figures reveal several facts of some importance. Among the human adults the brachycephals show all through a remarkably greater proportion of larger fossal length on the right and smaller on the left side than the mesocephals, and especially the dolichocephals. And similarly large percentage of longer right fossal length exists in the human young, the anthropoid apes, and the monkeys and lemur. Sex shows no particular difference, and the influence of race is small, if any. The brachycephals stand in this feature decidedly nearer the human young and the other primates than man, than the dolichocephals. It is, of course, possible that the prevalence of a greater fossal length on the right side is due to different causes in these several groups, but more likely there is some relation in these phenomena.

The actual differences in the combined fossal length ranged thus:

Anterior, middle, and postero-superior fossæ longer than the same of the opposite side.

Subjects.	0.5 mm.	0.1 mm.	1.5 mm.	2.0 mm.	2.5 mm.	3.0 mm.	3.5 mm.	4.0. mm.	4.5. mm.	5.0. mm.	5.5. mm.	6.0. mm.	Above 6.0. mm.
Human adults:													
Right longer.....cases..	8	5	1	0	2	0	1	4	2	2	1	1	*a* 2
Left longer .....do....	6	6	4	8	2	6	1	5	1	5	2	0	*b* 3
Human young:													
Right longer .....do....	4	7	2	5	2	0	0	0	0	0	0	0	0
Left longer .....do....	3	3	1	1	1	1	0	0	0	0	0	0	0
Anthropoid apes:													
Right longer .....do....	1	4	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Left longer .....do....	1	1	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....
Monkeys and lemur:													
Right longer .....do....	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Left longer .....do....	0	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

a 1 = 6.5 mm.; 1 = 7 mm. *b* 1 = 6.5 mm.; 1 = 8 mm.; 1 = 12 mm.

The greatest of the differences among the human adults are on the left side; also the proportion of cases with large differences is greater where the left combined fossal length is greater. In the human young the differences are smaller, showing that the peculiarity is to quite a large degree of later development, which agrees with what was observed with all the individual cavities. In anthropoid apes and monkeys the differences are relatively small, exceeding in no case 2 millimeters.

It remains to show how the combined fossal length agrees with the greatest ventral length of the skull of the same side. The succeeding table gives the averages of the right and left ventral antero-posterior diameters in human adults. It will be seen that here also, as with the $a + m + ps$ length the left diameter preponderates in the mass of the specimens, and it will also be noticed that in the white brachycephals there is scarcely any difference, while in the white dolichocephals, both male and female, the inequality is pronounced.

Ventral antero-posterior maximum diameter of the skull.

Subjects.	Males.						Females.					
	Dolichocephals.		Mesocephals.		Brachycephals.		Dolichocephals.		Mesocephals.		Brachycephals.	
	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.
	cm.	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
Whites	(8) 17.5	(8) 17.7 *a*(+0.2)	(12) 17.23	(12) 17.27 *a*(+0.04)	(9) 16.7	(9) 16.7 *a*(+−0)	(7) 16.3	(7) 16.6 *a*(+0.3)	(6) 16.4	(6) 16.5 *a*(+0.1)	(4) 15.9	(4) 15.95 *a*(+0.5)
Indians	(10) 16.6	(10) 16.7 *a*(+0.1)	.....	.....	(10) 15.3	(10) 15.4 *a*(+0.1)	.....	.....	.....	.....	.....	.....
Negroes	(13) 16.7	(13) 16.8 *a*(+0.1)	.....	.....	.....	.....	(7) 16.2	(7) 16.1 *a*(−0.1)	.....	.....	.....	.....

a Difference from the length on the right side.

After individual comparison, in the human adult, it is found that the relations of the combined fossal, and the ventral length, are as follows: Both measurements are alike on the two sides[a] in 14.7 per cent of cases. Both measurements are longer on the same side in 62.7 per cent of cases. One of the measurements is equal on the two sides, the other unequal, in 22.7 per cent of cases.

The instances where the measurements agree, either in that each is equal on the two sides of the skull, or in both being longer on the same side of the skull, constitute nearly four-fifths of the cases, so that agreement between the $a+m+ps$ length and the greatest ventral length on each side may be said to be almost general. Of the exceptions only a few are marked. The highest discrepancy was a 7 mm. difference in favor of the right combined fossal length in a case where the ventral lengths were equal.

The *interrelation* of the three cerebral cavities, shown hitherto only indirectly and incompletely, can be further brought out by comparing the lengths of the individual cavities with the sum of the lengths of the three, thus: $\frac{\text{length of } x \text{ fossa} \times 100}{\text{length of } a+m+ps^{b} \text{ fossæ}}$. The results, which can be termed indexes, and are convenient for collation, are given, with three columns of supplemental comparisons, in the table below.

[a] Differences up to one millimeter between the whole right and left side being disregarded, as a possible error can not in such cases be excluded.

[b] That is, of anterior and middle and postero-superior fossæ.

Indexes showing the interrelation of the cranial (cerebral) fossæ.

Subjects.	Number of skulls.	Index *a* of anterior fossa.		Index *b* of middle fossa.		Index *c* of the cerebral part of the posterior fossa.		Middle *d* *vs.* anterior fossæ (mean).	Postero-superior *e* *vs.* middle fossæ (mean).	Postero-superior *f* *vs.* mean of anterior and middle fossæ.
		Right.	Left.	Right.	Left.	Right.	Left			
Adults:										
Whites, males—										
Dolichocephals	14	28.1	27.4	29.0	28.8	42.9	43.8	104	150	152
Mesocephals	11	27.9	27.1	29.5	29.3	42.6	43.6	107	146	151
Brachycephals	11	27.7	26.8	30.5	30.6	41.9	42.6	112	138	146
Whites, females—										
Dolichocephals	5	28.0	27.1	29.5	28.6	42.5	44.1	105	149	153
Mesocephals	6	28.2	27.5	29.4	29.0	42.4	43.5	105	147	151
Brachycephals	6	27.9	27.5	29.3	29.3	42.8	43.2	106	147	151
Indians, males—										
Dolichocephals	10	26.1	25.7	29.7	28.7	44.1	45.7	113	154	163
Brachycephals	10	26.44	26.37	31.1	30.3	42.5	43.6	116	140	152
Negroes—										
Males, dolicho- and mesocephals	14	28.2	27.2	29.3	29.1	42.5	43.7	105	147	151
Females, dolicho- and mesocephals	5	29.1	28.0	28.4	28.3	42.4	43.7	99	152	151
Fetuses and young	40	29.7	29.4	27.7	27.5	42.5	43.1	93	155	150
Anthropoid apes:										
Chimpanzees	2	31.1*	30.2	30.6	30.4	38.3	39.4	99	127	126
Gorilla	1	27.7	27.1	31.2	29.6	41.1	43.3	111	138	146
Orangs	6	29.4	28.9	30.1	29.7	40.5	41.4	103	137	139
Gibbons	4	33.2	33.2	29.7	29.1	37.1	37.7	89	127	119
Monkeys, etc.:										
Cynocephalus	1	28.6	?	32.4	?	39.0	?	113	120	128
Macacus pelops	1	32.8	32.4	31.7	31.3	35.6	36.3	97	114	112
Cebus hypoleucus	1	31.1	30.7	31.8	32.0	37.1	37.3	103	116	118
Mycetes	1	31.3	?	35.4	?	33.3	?	113	94	100
Alouata seniculu	1	31.7	31.1	35.9	34.5	32.4	34.5	112	95	100
Midas	1	28.9	29.2	33.3	34.8	37.8	36.0	117	108	117
Lemur varius	1	35.5	35.8	36.3	36.6	28.2	27.6	102	76	77
Ursus americanus	1	?	?	?	?	?	?	105	.....	.....
Deer	1	?	?	?	?	?	?	90	.....	.....
Pig	1	?	?	?	?	?	?	84	.....	.....

[a=length of anterior fossa; m=length of middle fossa; ps=length of postero-superior fossa.]

$$^{a}\ \frac{a\times 100}{a+m+ps} \qquad ^{b}\ \frac{m\times 100}{a+m+ps} \qquad ^{c}\ \frac{ps\times 100}{a+m+ps}$$

d Mean length of anterior fossæ=100. *e* Mean length of middle fossæ=100. *f* Mean length of a anterior and m, middle fossæ $\left(\frac{a+m}{2}\right)=100$.

The middle fossæ are, it is seen, longer than the anterior ones in a large majority of the series; they are shorter than the anterior cavities in the negro females, the fetuses and young, the chimpanzees, gibbons, and the macaque. The longest middle fossæ in relation to the anterior ones exist in the Indians, gorilla, and several of the monkeys, while the shortest are found in the pig, the gibbons, and the human fetuses and young.

The length of the postero-superior cavities approximates one and a half times that of the anterior fossæ in all the series of human skulls; it is somewhat less in the anthropoid apes, much less in most of the monkeys, and least (only three-fourths of the length of the anterior cavities) in the lemur.

More simplified data are obtained by a comparison of the length of the postero-superior fossæ to the mean of the lengths of the anterior

and middle cavities. It is seen that the former exceed the latter in the proportion of 143–163 to 100 in the human crania, as 119–146 to 100 among the anthropoid apes, as 100–128 to 100 among the monkeys, and only as 77 to 100 in the lemur. The highest proportion among the human series (163 to 100) is found in the Indian male dolichocephals, the smallest (146 to 100) among the white male brachycephals and (150 to 100) in the young. Among anthropoid apes the highest proportion (146 to 100) exists in the gorilla, the smallest (119 to 100) in the gibbons; while among the monkeys similar extremes are represented by the baboon (128 to 100) and by the mycetes and alouata (100 to 100). It is striking how much zoological sequence there is in the distribution of these particular results of comparison. The position of the Indians, however, seems anomalous.

The indexes show many characteristics of the fossæ which have already been brought out in the comparisons of the length of the cavities with the lengths of the skull. To avoid repetitions and a possible confusion, these features are relegated to the general summary.

THE POSTERO-INFERIOR OR CEREBELLAR FOSSÆ.

The absolute average length of the cerebellar fossæ in the various series of human adults is as follows:

Posterior fossæ, cerebellar portion: Average length in adults.

Subjects.	Males.						Females.					
	Dolichocephals.		Mesocephals.		Brachycephals.		Dolichocephals.		Mesocephals.		Brachycephals.	
	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Whites	(20) 63.4	(20) 62.5 a(−0.9)	(19) 62.6	(19) 62.7 a(+0.1)	(19) 62.8	(19) 62.9 a(−0.1)	(10) 58.5	(10) 58.4 a(−0.1)	(9) 61.6	(9) 61.2 a(−0.4)	(9) 59.7	(9) 59.8 a(+0.1
Indians	(10) 64.0	(10) 63.3 a(−0.7)	.....	.....	(10) 59.3	(10) 59.1 a(−0.2)	.....	.....	.....	.....	.....	.....
Negroes	(15) 62.9	(15) 63.9 a(+1.0)	.....	.....	.....	.....	(10) 60.0	(10) 59.4 a(−0.6)	.....	.....	.....	.....

a Differences from the right fossæ.

The right cavity, it is seen, exceeds the left in length in a pronounced manner in the white and Indian male dolichocephals, and a little less so in two of the female series, but is decidedly smaller in the male negro. In the brachycephals the differences are throughout immaterial. It is plain that correlation between the cerebellar and posterior cerebral cavities, if it exists at all, is very limited. During the measuring in whites it was very often noticed that the groove and ridges of the lateral sinus on the left side were lower than those on

the right, but this was not always associated with a smaller length of the left postero-inferior fossa.

In detail the differences in the cerebellar cavities were distributed thus:

Length of postero-inferior fossa on the two sides.

Skulls.	Right cerebellar fossa longer (per cent of cases).	Fossæ equal (per cent of cases).	Left cerebellar fossa longer (per cent of cases).
Adults:			
Whites, males—			
Dolichocephals	50	20	30
Mesocephals	53	11	37
Brachycephals	26	32	42
Whites, females—			
Dolichocephals	30	10	50
Mesocephals	33	33	33
Brachycephals	50	12	38
Indian, males—			
Dolichocephals	60	20	20
Brachycephals	60	0	49
Negroes—			
Males, dolicho- and mesocephals	33	7	60
Females, dolicho- and mesocephals	50	20	30
Human fetuses and young	25	38	35
Anthropoid apes	15	38	47
Monkeys and lemur	20	40	40

The results, so far as the human adults are concerned, agree in general with those shown by the first table of this part of the paper. There is a larger proportion of longer fossæ on the right than on the left side in the white and Indian male dolichocephals, and smaller in the male negroes. Greater numbers of crania, particularly brachycephalic, would have been very desirable in this connection. In the human young, anthropoid apes, and monkeys are seen relatively small percentages of longer right fossa, with larger percentages of longer left fossa and of equal cavities. Comparing the conditions found in the human young with those in adults, it is seen that in a large proportion of cases the excess in length in the right cerebellar fossa takes place after fetal life has been completed.

The absolute differences in length of the two cerebellar cavities were in some of the skulls quite marked, but on the whole were less than those of the postero-superior fossæ. They ranged as follows:

Absolute differences in length of the cerebellar fossæ; right fossa the longer in cases:

Subjects.	0.5 mm.	1.0 mm.	1.5 mm.	2.0 mm.	2.5 mm.	3.0 mm.	3.5 mm.	4.0 mm.	4.5 mm.	5.0 mm.	Above 5.0 mm.
Human adults	9	13	5	7	8	5	4	4	1	1	.....
Human fetuses and young	4	6	.....	.....	.....	.....	.....	.....	.....	.....	.....
Anthropoid apes	0	0	0	1	1	.....	.....	.....	.....	.....	.....
Monkeys and other mammals	0	1	.....	.....	.....	.....	.....	.....	.....	.....	.....

Absolute differences in length of the cerebellar fossæ; left fossa the longer in cases:

Subjects.	0.5 mm.	1.0 mm.	1.5 mm.	2.0 mm.	2.5 mm.	3.0 mm.	3.5 mm.	4.0 mm.	4.5 mm.	5.0 mm.	Above 5.0 mm.
Human adults	9	13	6	7	4	5	1	1	2	1	a2
Human fetuses and young	2	5	3	2	1	0	0	1	.....	.....	.....
Anthropoid apes	1	1	1	2	0	0	1	.....	.....	.....	.....
Monkeys and other mammals	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....

a1=5.5 mm.; 1=11 mm.

In human adults the scales of inequalities are very nearly alike; in the fetuses, and to a lesser extent in the apes, the differences on the left side are more pronounced than those on the right.

The relation between the mean length of the cerebellar fossæ and the size of the skull (estimated on the base of the mean of the greatest cranial length and breadth) is indicated in the next table, the skulls represented being the same as with the cerebral fossæ in similar comparisons:

Average relation of the mean length of the two postero-inferior (cerebellar) fossæ to the greatest dorsal and mean ventral length of the skull (each of these diameters being taken as 100) in the largest and smallest skulls of the series.

Subjects.	Number of specimens.	In the largest crania—		Number of specimens.	In the smallest crania—	
		vs. external length.	*vs.* internal length.		*vs.* external length.	*vs.* internal length.
Adults:						
White males	6	33.4	36.2	6	34.1	37.0
White females	6	33.6	36.9	6	34.5	37.6
Indian males	6	35.5	38.8	6	35.0	37.9
Negroes, both sexes	5	32.8	36.3	5	35.7	38.8

Except in the Indian males, the fossæ in the smallest crania are in all the groups relatively longer than those in the largest skulls of the series, which means that the cerebellum increases in length in a slightly lower ratio than the skull. It is rather remarkable that the negroes show in this respect, as on many former occasions, nearer the whites than the Indians, while in many external features of the skull the Indians are intermediary between the two.

The absolute and relative length proportions of the cerebellar fossæ, contrasted between adults and young, man and animals, sexes, races, and in the main cranial forms, are as follows:

Length proportions of postero-inferior fossæ in relation to greatest external and mean internal length of the skull.

Subjects.	Number of skulls.	Average external maximum length of skull.	Average mean length of the 2 postero-inferior fossæ.	Average relation of the length of the fossæ to the dorsal length of the skull.	Average relation of the length of the fossæ to the ventral length of the skull.	Number of skulls.
		cm.	*mm.*			
Adults:						
Whites, males—						
Dolichocephals	14	19.4	63.4	33.0	35.7	10
Mesocephals	11	18.7	63.7	34.0	36.4	14
Brachycephals	11	18.2	62.9	34.4	37.5	10
Whites, females—						
Dolichocephals	5	17.8	58.6	32.9	35.6	10
Mesocephals	6	17.8	61.1	34.4	37.0	9
Brachycephals	6	17.3	60.4	35.0	38.2	5
Indians, males—						
Dolichocephals	10	18.3	63.6	34.8	38.2	10
Brachycephals	10	16.9	59.2	34.9	38.5	10
Negroes:						
Males, dolicho- and mesocephals	14	18.6	63.9	34.4	37.9	13
Females, dolicho- and mesocephals	5	17.7	60.3	34.1	37.1	8
White fetuses and children, brachycephals	10	.....	27.2	36.0	38.0	8
Colored fetuses and children:						
Brachycephals	10	.....	32.2	37.0	36.4	10
Dolicho- and mesocephals	20	.....	32.2	33.3	35.1	20
Anthropoid apes:						
Chimpanzees	2	11.9	42.8	36.0	38.8	2
Orangs	6	11.9	41.2	34.5	39.1	6
Gibbons	4	7.5	24.6	32.6	33.8	4
Monkeys and lemurs:						
Macacus pelops	1	8.2	24.0	29.2	31.2	1
Cebus hypoleucus	1	7.5	18.7	25.0	28.0	1
Alouata seniculu	1	7.0	20.5	29.3	34.9	1
Midas	1	4.1	11.5	28.0	29.3	1
Lemur varius	1	6.0	16.0	26.7	30.2	1

The average relative proportions of the cerebellar fossæ differ, it is seen, but little between human adults and human young, both groups taken as a whole. If the cases are taken individually, it is found that there is a greater variation in the relative proportions of the cavities in the fetuses and young than in the adults (young, 27.2–47.2; adults, 28.8–40.1; in the young, proportions below 30 in 9 per cent and above 40 in 5.1 per cent of the fossæ, in adults, those below 30 in 1.5, those above 40 in 0.4 per cent of the cavities). These greater inequalities in the young are in all probability due more to the relatively abundant tissues about and especially in the rear of the cerebellum than to variation in the hind-brain itself. The volume itself of the fetal cerebellar fossæ would be smaller were these tissues not present, and their relative length would not equal that in the adults. Among anthropoid apes the relative dimensions of the cerebellar fossæ in the chimpanzee and orang are much like those in some of the series of human adults, but those in the gibbon are noticeably lower, and they are still lower, with one exception, in the monkeys and lemur.

The adult human cerebellum is, therefore, relatively somewhat longer than it is in gibbons and lower primates.

Sexual differences are insignificant in the whites as well as the negroes.

As to racial differences, there is a slight excess in the relative length of the cerebellar fossæ (as there was with the postero-superior ones) in favor of the Indians. Again in this instance the negroes appear nearer to the whites than the Indians.

Finally, the data show the existence of decided differences in the relative length of the cerebellar fossæ between the main cranial forms; the proportion is throughout, even in the young, greater in the brachycephals than in the dolichocephals. A somewhat similar condition was seen also with the postero-superior cavities.

The relation of the length of the cerebral to that of the cerebellar portion of the posterior fossæ is shown in the last table of this section. In conformity with the separate data concerning the two cavities, the cerebellar fossa is seen to be relatively longer in all the brachycephals than in the dolichocephals. In the dolicho- and mesocephalic fetuses and young the cerebellar fossa is relatively shorter than in the adults; in the orangs and gibbons the relation of the two cavities is nearly as that in man, but in most of the monkeys it shows larger differences. In the lemur, finally, the superior part of the fossa shows but a slight excess over the inferior.

Relation of the length of the cerebellar to that of the posterior cerebral (postero-superior) fossæ.

Subjects.	Number of skulls.	Proportion, the cerebellar fossæ=100.
Adults:		
Whites, males—		
Dolichocephals	20	129
Mesocephals	19	127
Brachycephals	19	124
Whites, females—		
Dolichocephals	10	129
Mesocephals	9	126
Brachycephals	8	125
Indians, males—		
Dolichocephals	10	127
Brachycephals	10	125
Negroes—		
Males, dolicho- to mesocephals	15	121
Females, dolicho- to mesocephals	10	126
Fetuses and young:		
Dolicho- and mesocephals	20	134
Brachycephals	19	126
Anthropoid apes:		
Chimpanzees	2	116
Gorilla	1	140
Orangs	6	124
Gibbons	4	125
Monkeys, etc.:		
Cynocephalus	1	158
Macacus pileps	1	135
Cebus hypoleucus	1	149
Myceles	1	140
Alouata senicula	1	120
Midas	1	143
Lemur varius	1	108

SUMMARY OF THE RESULTS OF MEASUREMENTS OF THE CRANIAL FOSSÆ.

Results obtained from the absolute measurements and by comparing the length of the fossæ with the dorsal and ventral lengths of the skull.	Results obtained by comparing the length of the fossæ with their combined length, and among themselves.
ANTERIOR FOSSÆ.[a]	ANTERIOR FOSSÆ.[a]
1 (*a*) The average absolute length of the right cavity is somewhat greater than that of the left in all the human series, in all the anthropoid apes except the gibbons, and in some other primates and lower mammals.	1 (*a*) The average absolute length of the right cavity is somewhat greater than that of the left in all the human series, in all the anthropoid apes except the gibbons, and in some other primates and lower mammals.
(*b*) Individually, the largest percentage of longer right fossæ and the most pronounced differences between the length of the two cavities occur in the human adults, and then in the higher anthropoid apes (chimpanzee, gorilla, orang).	(*b*) Individually, the largest percentage of longer right fossæ and the most pronounced differences between the length of the two cavities occur in the human adults, and then in the higher anthropoid apes (chimpanzee, gorilla, orang).
2. There is a prevalence of relatively short anterior fossæ in the largest, and of relatively long fossæ in the smallest skulls.	
3 (*a*) The mean length of the anterior cavities is relatively greater in the human fetuses and young than it is in human adults.	3 (*a*) The mean length of the anterior cavities is relatively greater in the human fetuses and young than it is in human adults.
(*b*) It is also greater in most of the primates and other mammals examined than in the human adults.	(*b*) It is also greater in most of the primates and other mammals examined than in the human adults.
(*c*) It is slightly greater in the human adult females than in the males.	(*c*) But little difference in whites; length greater in negro females than in males.
(*d*) It is nearly alike in the whites and the negroes, but is smaller in the Indians; and, finally,	(*d*) Smaller in the Indians; slightly greater in the negroes than in whites.
(*e*) It it slightly smaller in the dolicho- than in the brachycephalic skulls.	(*e*) Somewhat greater in the dolichocephalic male whites, smaller in the dolichocephalic Indians, than in brachycephals.
MIDDLE FOSSÆ.	MIDDLE FOSSÆ.
1 (*a*) The average absolute length of the right cavity is slightly greater than that of the left in a large majority of the human series and in the anthropoid apes, while in the other primates and mammals the two fossæ are in average about equal.	1 (*a*) The average absolute length of the right cavity is slightly greater than that of the left in a large majority of the human series and in the anthropoid apes, while in the other primates and mammals the two fossæ are in average about equal.
(*b*) Individually, the largest percentage of longer right middle fossæ and the most pronounced differences between the length of the cavities occur in several series of the human adults (in the dolichoecephals), and then in the anthropoid apes.	(*b*) Individually, the largest percentage of longer right middle fossæ and the most pronounced differences between the length of the cavities occur in several series of the human adults (in the dolichoecephals), and then in the anthropoid apes.
(*c*) Compensation in length with the anterior fossæ appears possible in only a limited proportion of cases. In one-third of the skulls the middle cavity was greater in length on the same side as the anterior.	
2. The differences in the relative length of the middle fossæ between the largest and smallest skulls are not well defined.	
3 (*a*) The mean length of the middle cavities is, relatively, smaller in the human young than in adults.	3 (*a*) The mean length of the middle cavities is, relatively, smaller in the human young than in adults.
(*b*) It is greater than in the adult man in the anthropoid apes, and especially so in the monkeys and other mammals.	(*b*) Slightly greater in some anthropoid apes, decidedly greater in monkeys and lemur (also in other mammals examined) than in man.

[a] It should be borne in mind that the two headings represent not equal, but only cognate, aspects of the case, mathematically as well as morphologically. This accounts for the several differences that will be observed.

Summary of the results of measurements of the cranial fossæ—Continued.

Results obtained from the absolute measurements and by comparing the length of the fossæ with the dorsal and ventral lengths of the skull.	Results obtained by comparing the length of the fossæ with their combined length, and among themselves.
MIDDLE FOSSÆ—continued.	MIDDLE FOSSÆ—continued.
(*c*) Differences are quite immaterial in whites, though there is a tendency to smaller relative proportions in the females: in negroes, smaller in the females.	(*c*) Fossæ smaller in the female negro.
(*d*) Differences quite immaterial, though somewhat smaller than in any other adult human series in the female negro.	(*d*) Fossæ somewhat smaller in the negroes of both sexes than in other human adults
(*e*) The relative length of the middle fossæ is throughout smaller in the dolicho- than in the brachycephals.	(*e*) The relative length of the middle fossæ is throughout smaller in the dolicho- than in the brachycephals.
CEREBRAL PART OF THE POSTERIOR FOSSÆ.	CEREBRAL PART OF THE POSTERIOR FOSSÆ.
1 (*a*) The average absolute length of the right cavity is decidedly shorter than that of the left side in all the series of human adults and anthropoid apes, moderately shorter in the human young, and slightly shorter in the lower primates and other animals.	1 (*a*) The average absolute length of the right cavity is decidedly shorter than that of the left side in all the series of human adults and anthropoid apes, moderately shorter in the human young, and slightly shorter in the lower primates and other animals.
(*b*) Individually, the largest percentage of longer left fossæ and the most pronounced differences between the length of the two cavities occur (as with the anterior and middle fossæ) in the human adults, and then in anthropoid apes.	(*b*) Individually, the largest percentage of longer left fossæ and the most pronounced differences between the length of the two cavities occur (as with the anterior and middle fossæ) in the human adults, and then in anthropoid apes.
(*c*) The length of the posterior fossa stands frequently in compensatory relation with the combined length of the anterior and middle fossæ on the same side.	
There are no regular or large differences in the relative length of the postero-superior fossæ between the largest and smallest skulls.	
3 (*a*) The mean relative length of the postero-superior cavities, compared with the mean ventral antero-posterior diameter of the skull, is, in the human fetuses and young, slightly greater than in some series of the adults and smaller than in others.	3 (*a*) The left fossa in the young shows smaller, the right about equal index, as compared with that in adults; contrasted with the combined length of the anterior and middle fossæ, it appears smaller than in the adults.
(*b*) It is smaller than in adult man in anthropoid apes (except the orang), monkeys, and especially in the lemur.	(*b*) It is smaller than in adult man in anthropoid apes (except the orang), monkeys, and especially in the lemur.
(*c*) There is no material difference between the sexes.	(*c*) There is no material difference between the sexes.
(*d*) From the racial point of view, the length is relatively greatest in the Indians; it is nearly alike in the whites and the negroes; finally,	(*d*) From the racial point of view, the length is relatively greatest in the Indians; it is nearly alike in the whites and the negroes; finally,
(*e*) It is greater in the brachycephals than in the dolichocephals among the whites, but smaller in the former than in the latter among the Indians.	(*e*) The index is somewhat greater in all but one of the series of dolichocephals than in the brachycephals, and comparison of the length of the postero-superior fossæ with that of the anterior and middle fossæ, shows excess for dolichocephals in all the series.

The combined length of the three cerebral fossæ is greater on the left in from 64 to 80 per cent of the adult dolicho- and mesocephals, but there is a prevalence of greater length on the right side in the brachycephals, the young and the primates.

CEREBELLAR FOSSÆ.

1 (*a*) The right cavity shows a greater average absolute length in adult white males and in the Indian male dolichocephals, but is shorter than the left in the adult male as well as in female negroes. Among brachycephals, white and Indian, the differences are immaterial.

(*b*) In human fetuses and young in anthropoid apes, monkeys, and lemurs the left fossa is more often the longer.

(*c*) Correlation between the length of the cerebellar and any of the individual cerebral fossæ is nil, or very limited.

2. In the largest skulls the cerebellar fossæ are relatively shorter than in the smallest crania.

3 (*a*) The mean length of the cerebellar cavities is, relatively, somewhat smaller in the human young than in adults.

(*b*) It is like in man in the chimpanzee and orang, but is smaller in the gibbon, and especially so in the monkeys and lemur.

(*c*) Sexual differences are quite immaterial.

(*d*) As to races, the fossæ are relatively nearly alike in the whites and the negroes, but are longer in the Indians; finally,

(*e*) The relative length of the cerebellar fossæ is greater in all the series of brachycephals than in dolichocephals.

With all the four fossæ, and in all series, that cavity which is more often the longer than its mate of the opposite side shows generally also a larger range of the excesses of measurement.

If the above results of the studies on the skull are now applied to the brain itself, i. e., to those parts of the brain represented by the measurements taken, the indications are that—

In human adults, in general, the cerebrum presents in the majority of cases a greater basal length (as obtained by the measurements here dealt with) on the left side; the length of the frontal lobe is somewhat greater on the right than on the left side; the length of the parietal lobe is slightly greater than that of the frontal, and in most instances is also slightly greater on the right than on the left side; compensation in length with the frontal lobe appears to be very limited; the length of the occipital lobe is decidedly greater than that of the frontal or that of the parietal lobe (with the former as nearly 1.5 to 1, with the latter as over 1.5 to 1); and it is decidedly greater, in a large majority of brains, on the left side; there exists frequently a compensation in length between the two more anterior lobes and the occipital; the length of the cerebellum is smaller than that of the occipital lobe, but is always in excess of that of either the anterior or the middle lobe of the cerebrum; the right lobe shows in some of the series (whites) a prevalence of greater length on the right side; in others (negroes) on the left side; no correlation appears between the length of the cerebellum and that of the occipital, or any other portion of the cerebrum; the largest adult human brain shows a relatively smaller length of the anterior lobes than do the smallest specimens; with other portions of the organ the differences in this respect are irregular.

In human fetuses and young in general, the relative length of the anterior lobes is greater than that in adults; the average length of the right lobe is already somewhat greater than that of the left, but individually there are many more cases than in the adults in which the two are equal; the length of the parietal lobes is smaller than that of the frontal (a reverse condition from that found in adults): the right lobe is the longer more often than the left, but in one-half of the specimens they are equal; the relative length of the parietal lobes is less than in adults; the relative length of the occipital lobes, or at least of that on the left side, is slightly smaller than the general average in adults; there is a prevalence of longer left lobe, but the proportion of equally long lobes is larger than among the adults; the relative length of the cerebellum is somewhat smaller than in adults; and the left lobe is more often the longer.

In the anthropoid apes, monkeys, and other mammals (so far as represented), the relative length of the frontal lobes is, with a few exceptions, greater than in human adults and often greater even than in human young; the right lobe is probably longer in all the apes except gibbons, and was found longer individually also in some of the other primates and mammals (the differences being greatest in the higher apes); the length of the parietal lobes is greater than that of the frontal in the gorilla and orangs, and in several of the monkeys, but is smaller in the gibbons, macaque, deer, and particularly in the pig; the right lobe is prevalently the longer among the anthropoid apes only; the relative length of the lobes is greater in anthropoid apes, and especially in the monkeys and other mammals, than it is in adult man; the relative length of the occipital lobe is smaller in anthrophoid apes than in man, and still smaller in the monkeys and lemurs; in mycetes, alouata, and especially in lemur, it is shorter than either the frontal or parietal lobe; the left lobe is prevalently the longer in the apes and among monkeys, but was found shorter than the right in midas and lemur; the relative length of the cerebellum is somewhat greater than in adult man in the chimpanzee and orangs, but is smaller in the gibbons and other primates with lemurs.

Sexual differences in the brain are, so far as here dealt with, but few in number and not large. Relatively the anterior lobes are slightly longer in the females than in the males, and there is apparently some correlated tendency in the females, especially in the negroes, to smaller relative length of the parietal lobes.

Racial brain differences indicated by the results of this study are as follows: The relative length of the anterior lobes is smaller in the Indians than in the whites and negroes (in whom it is nearly alike); the middle lobes are relatively smaller in the female negro than in any other series of human adults; the occipital portions are relatively longer in the Indians than in the whites and negroes (in whom they are

nearly alike); the cerebellum shows the prevalence of a greater length of the left lobe (in some whites and Indians right lobe); and the length of the hindbrain is relatively more considerable in the Indian than in the white or negro (in whom it is nearly alike).

Finally, as to brain differences in the principal forms of the skull, it was found that the relative length of the frontal lobes is somewhat smaller in the dolicho- than in the brachycephals; the relative length of the parietal lobes is throughout smaller in the dolicho- than in the brachycephals; the relative length of the occipital portions of the cerebrum is on the whole larger in the dolichocephals (see indexes of the fossæ and comparison of the length of the postero-superior fossa with that of the anterior and middle cavities); finally, in the cerebellar length, the dolichocephals show more difference on the two sides than the brachycephals, but the brachycephals show throughout a greater relative length of the hindbrain than the dolichocephals.

On the basis of this study the following characteristics of the adult human skull or brain may be viewed as of lower developmental order: A large relative length of the frontal fossæ, or frontal lobes (infantile and animal feature); a small relative length of the middle fossæ, or parietal lobes (infantile feature); a small relative length of the cerebral part of the posterior fossa, or the portion of the cerebrum it contains (infantile and animal feature), and a smaller relative length of the cerebellar fossa, or the cerebellum (infantile and animal feature).

Looking at the series of examined skulls in this light, the male skulls show a little more favorably than the female; racially we are confronted with the curious and most unexpected fact of the quite close position of the whites and negro males and a more advanced differentiation of the Indian over both, while as to cranial types the dolichocephals show some developmental superiority in the frontal and postero-superior fossæ and corresponding lobes, the brachycephals in the middle fossæ, or lobes, and in the relative length of the whole cerebrum.

Much larger series of specimens would very likely accentuate many, and probably modify a few, of the results obtained with the numbers available to the writer. It is to be hoped further opportunities in this respect will arise and be utilized here or elsewhere with other investigations in the future. Measurements on the brain itself could, perhaps, take to some extent the place of those on the fossæ, though more confidence must remain with the latter, which are not subject to deformation.

EXTERNAL LENGTH OF SKULL COMPARED WITH THE INTERNAL.

There are several items of interest which were inquired into in connection with the preceding study.

One of these is the relation in the several series between the greatest external and the greatest mean internal length of the skull. The comparison given in the succeeding table shows a slight excess in the thickness of the skull in the white brachycephals over that in the white dolichocephals; a slight excess in the Indians over whites; and an appreciable excess in the negroes over the Indians. These differences explain better than has been done heretofore the discrepancies noticed between the comparisons of the cranial fossæ with the dorsal and ventral lengths, and demonstrate the greater suitability of the latter for such a function.

Diameter antero-posterior maximum of the skull dorsally compared with mean diameter antero-posterior maximum ventrally.

Subjects.	Males.						Females.					
	Dolichocephals.		Mesocephals.		Brachycephals.		Dolichocephals.		Mesocephals.		Brachycephals.	
	D. a-p. m.	D. a-p. m'n (ventr.)	D. a-p. m.	D. a-p. m'n (ventr.)	D. a-p. m.	D. a-p. m'n (ventr.)	D. a-p. m.	D. a-p. m'n (ventr.)	D. a-p. m.	D. a-p. m'n (ventr.)	D. a-p. m.	D. a-p. m'n (ventr.)
	cm.	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
Whites.	(8) 19.1	17.7 a(−1.4)	(12) 18.7	17.3 a(−1.4)	(9) 18.2	16.7 a(−1.5)	(7) 17.8	16.6 a(−1.2)	(6) 17.8	16.5 a(−1.3)	(4) 17.3	15.9 a(−1.4)
Indians	(10) 18.3	16.7 a(−1.6)	.....	.....	(10) 16.9	15.4 a(−1.5)	.....	.....	.....	.....	.....	.....
Negroes	(13) 18.5	16.8 a(−1.7)	.....	.....	.....	.....	(7) 17.9	16.2 a(−1.7)	.....	.....	.....	.....

a Difference from dorsal length.

In order to see how other lengths of the anterior fossæ, and especially their relation to the ventral length of the skull, agree with the measurement chosen and its relations, the writer secured also in most of the specimens utilized the distance from the foramen cœcum to the anterior boundary of the pituitary fossa. The table beneath gives the results and these, it will be seen, express much the same conditions as were found with the regular measurement of the frontal cavity. There is (except in the white females where the small number of specimens is evidently at fault) again a predominance of the length in the brachycephals over that in the dolichocephals, and there are seen

again the smaller relative proportions of the measurement in the Indians than in the whites and negroes of a similar head form. A disadvantage to this measurement consists in the variation in the region just anterior to the pituitary fossa.[a]

FORAMEN CŒCUM TO PITUITARY FOSSA.

Length from foramen cæcum to pituitary fossa.

Subjects.	Adult males.			Adult females.		
	Dolicho-cephals.	Meso-cephals.	Brachy-cephals.	Dolicho-cephals.	Meso-cephals.	Brachy-cephals.
	cm.	cm.	cm.	cm.	cm.	cm.
Whites	(20) 5.06	(20) 4.90	(20) 4.82	(8) 4.78	(8) 4.78	(8) 4.70
Indians	(10) 4.54	.....	(10) 4.44	.....	.....	.....
Negroes	(15) 4.76	.....	.....	(10) 4.61	.....	.....

Relation of length from foramen cæcum to pituitary fossa, to the mean ventral cranial length (the latter = 100).

Subjects.	Adult males.			Adult females.		
	Dolicho-cephals.	Meso-cephals.	Brachy-cephals.	Dolicho-cephals.	Meso-cephals.	Brachy-cephals.
Whites	(11) 28.2	(14) 28.4	(10) 29.8	(8) 29.1	(7) 29.2	[a]28.1
Indians	(10) 27.2	.....	(10) 28.9	.....	.....	.....
Negroes	(13) 28.7	.....	.....	(8) 28.6	.....	.....

[a] 4 cases only.

GREATEST VENTRAL FRONTAL BREADTH.

Finally, an effort was made to measure the greatest frontal ventral diameter corresponding to the greatest breadth of the frontal lobe. This measurement could be more profitably taken on the brain itself, or on casts of the frontal part of the cranium. There is found in almost every skull, on each side, and just anterior to the coronal suture, a marked depression, which probably corresponds to the greatest expanse of the frontal lobe, but definite landmarks from which to measure are lacking. Notwithstanding this difficulty, certain interesting results have been arrived at, namely:

[a] See A. Hrdlicka, Dimensions of the Normal Pituitary Fossa in the White and the Negro Races; Arch. of Neurology and Psychopathology, Utica, N. Y., I, No. 4, 1898.

Breadth, maximum, of frontal region (ventrally).

Subjects.	Adult males.			Adult females.		
	Dolicho-cephals.	Meso-cephals.	Brachy-cephals.	Dolicho-cephals.	Meso-cephals.	Brachy-cephals.
	cm.	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
Whites	(17) 9.9	(16) 10.5	(15) 10.8	(6) 9.3	(8) 9.6	(5) 10.0
Indians	(6) 9.7		(3) 10.8			
Negroes	(14) 10.2			(10) 9.7		

Breadth, maximum, of frontal region, ventrally, compared with breadth maximum of the skull dorsally.

Subjects.	Adult males.			Adult females.		
	Dolicho-cephals.	Meso-cephals.	Brachy-cephals.	Dolicho-cephals.	Meso-cephals.	Brachy-cephals.
Whites	(17) 71.3	(16) 71.9	(15) 70.6	(6) 71.5	(8) 70.0	(5) 71.0
Indians	(6) 71.9		(3) 73.0			
Negroes	(14) 73.3			(10) 72.6		

Fetuses and young, both sexes:	
White, brachycephalic (6)	80.9
Colored—i. e., negro and negro-white—	
Brachycephalic (10)	80.7
Dolicho- and mesocephalic (20)	82.3
Apes—	
1 chimpanzee	79.8
6 orangs	77.8
4 gibbons	79.2
Monkeys—	
1 *Macacus pelops*	79.4
1 *Alouata senicula*	78.6
1 *Cebus hypoleucus*	79.3
1 *Lemur varius*	80.5
1 *Ursus americanus*	75.3

At first sight the above data are quite striking, but it must be remembered that the frontal breadth has been compared with the dorsal breadth of the skull, which varies in the different series. The proper way would be to compare the former with the greatest ventral breadth in all the skulls, but the latter measurement is difficult and in the material here utilized was not always possible.

The thickness of the skull is very nearly the same in human fetuses and young, in gibbons, alouata, cebus, and lemur, and the data obtained on these specimens are directly comparable.

In the orangs and chimpanzees the thickness of the two parieties at the location of the greatest breadth of the skull exceeds that in the human young by about 5 mm., in the negro by about 7 mm., in the Indian and white male by about 6 mm., and in the white female by about 5 mm. Reducing the greatest external breadth of the skulls in question by these figures and comparing the greatest internal frontal breadth with the remaining proportions, we obtain the following data, which are quite suitable for comparisons with the human young, gibbons, and other above-named species.

The greatest ventral frontal breadth compared with greatest breadth of the skull (reduced), the latter taken as 100.

Adult white males	74.3	Chimpanzees	75.0
Adult white females	73.5	Orangs	77.8
Adult Indians	75.6	Gibbons	79.2
Adult negroes	76.9	Monkeys	79.0
Human fetuses and young	81.6	Lemur	80.5

It appears that the difference between the greatest breadth of the frontal lobes and the greatest breadth of the skull, or, respectively, of the cerebrum, is less in the lemur and in most of the lower primates, as well as in the human fetuses and young, than it is in human adults, particularly among whites. With all their imperfections, these determinations point to another line of anthropometric studies on the brain, promising interesting results.

The detail tables of measurement of the cranial fossæ are appended to facilitate control of the preceding data, as well as the utilization of the series for future studies; and to show the individual variations which could not be dealt with conveniently in the text.

DETAILED DATA.

Summary of absolute and relative lengths of the cranial fossæ.

Subjects.	Average dorsal antero-posterior maxim. diameter of skulls.	Absolute lengths.				Ratio of length of fossæ to greatest dorsal length of skull.				Ratio of length of fossæ to mean ventral length of skulls.			
		Anterior fossæ.	Middle fossæ.	Postero-superior fossæ.	Cerebellar fossæ.	Anterior fossæ.	Middle fossæ.	Postero-superior fossæ.	Cerebellar fossæ.	Anterior fossæ.	Middle fossæ.	Postero-superior fossæ.	Cerebellar fossæ.
Adults:													
Whites, males—	*cm.*	*mm.*	*mm.*	*mm.*	*mm.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Dolichocephals	19.4	52.7	54.9	82.1	63.4	27.3	28.3	42.4	33.0	29.3	31.9	45.9	35.7
Mesocephals	18.7	51.5	55.2	80.7	63.7	27.5	29.4	43.0	34.0	29.5	32.2	46.0	36.4
Brachycephals	18.2	49.8	55.9	77.3	62.9	27.3	30.7	42.4	34.4	29.6	33.9	46.4	37.5
Whites, females—													
Dolichocephals	17.8	48.2	51.0	75.9	58.6	27.1	28.6	42.6	32.9	29.4	31.4	45.8	35.6
Mesocephals	17.8	49.7	52.4	76.9	61.1	28.1	29.5	43.3	34.4	30.4	33.0	46.8	37.0
Brachycephals	17.3	48.6	51.4	75.3	60.4	28.2	29.8	43.5	35.0	30.0	32.0	47.4	38.2
Indians, males—													
Dolichocephals	18.3	46.6	52.5	80.8	63.6	25.5	28.7	44.2	34.8	28.0	31.5	48.5	38.2
Brachycephals	16.9	45.4	52.7	73.8	59.2	26.8	31.2	43.6	34.9	29.5	34.3	48.0	38.5
Negroes—													
Males, dolicho- and meso-cephals	18.6	50.6	53.5	78.7	63.9	27.3	28.8	42.4	34.4	30.4	31.9	46.7	37.9
Females dolicho- and meso-cephals	17.7	50.2	49.7	75.5	60.3	28.3	28.1	42.7	34.1	31.0	31.1	46.9	37.1
Human fetuses and young	9.1	28.1	26.2	41.1	30.9	30.8	28.8	44.5	34.1	32.5	30.2	46.9	36.1
Apes:													
Chimpanzees	11.9	39.0	38.5	49.8	42.8	32.9	32.3	41.7	36.0	35.3	34.8	45.0	38.8
Gorilla	.....	38.7	43.0	59.7	42.7	.....	.....	.....	.....	.....	.....	.....	.....
Orangs	11.9	36.2	37.1	51.0	41.2	30.4	31.1	42.8	34.5	34.4	35.3	48.5	39.1
Gibbons	7.5	27.3	24.2	30.8	21.6	36.2	32.0	40.7	32.6	37.5	33.2	42.3	33.8
Monkeys and lemurs:													
Macacus prolops	8.2	29.5	28.5	32.5	24.0	36.0	34.7	39.6	29.2	38.3	37.0	42.2	31.2
Cebus hypoleucus	7.5	23.2	24.0	28.0	18.7	30.0	32.0	37.3	25.0	34.7	35.8	41.8	28.0
Alouata seniculu	7.0	23.0	25.7	24.5	20.5	32.9	36.8	35.0	29.3	39.1	43.8	41.7	34.9
Midas	4.7	13.0	15.2	16.5	11.5	31.7	37.2	40.2	28.0	33.1	38.8	42.0	29.3
Lemur varius	6.0	22.0	22.5	17.2	16.0	36.7	37.5	28.7	26.7	41.5	42.4	32.5	30.2

Cranial fossæ (ventral). Adult males, whites, dolichocephals (cephalic index below 75).

No.	Collection.	Nationality.	Skull.			Anterior fossa.				Middle fossa.				Posterior fossa, cerebral part.				Sum of the lengths of the fossæ.		Skull.		Foramen cecum to anterior border of pituitary fossa.	Breadth maximum of frontal region, ventrally.	Length of posterior fossa, cerebellar portion.	
			Diameter antero-posterior maximum.	Diameter lateral maximum.	Cephalic index.	Length.		Index.		Length.		Index.		Length.		Index.				Diameter antero-posterior maximum, ventrally.					
						Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.			Right.	Left.
			cm.	*cm.*		*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
39.5, 1894-95	(C.U.)[a]	Ireland	19.60	13.60	*69.39*	5.40	5.30	*28.12*	*27.60*	5.60	5.60	*29.17*	*29.17*	8.20	8.30	*42.71*	*43.23*	19.20	19.20	18.05	(?)	4.7	10.0	6.50	6.45
	(C.U.)	(?)	20.40	14.30	*70.10*	5.50	5.80	*27.92*	*28.50*	5.80	5.75	*29.44*	*28.26*	8.40	8.80	*42.64*	*43.24*	19.70	20.35	(?)	(?)	5.2	10.7	6.70	6.80
540	(C.U.)	Ireland	19.90	14.05	*70.60*	5.25	5.15	*27.27*	*26.21*	5.40	5.50	*28.05*	*27.99*	8.60	9.00	*44.67*	*45.80*	19.25	19.65	18.40	18.50	4.9	10.2	6.30	5.95
1092x	(C.U.)	(?)	19.40	13.90	*71.65*	(?)	5.25	(?)	*28.07*	(?)	5.60	(?)	*29.95*	7.70	7.85	(?)	*41.98*	(?)	18.70	(?)	(?)	5.1	(?)	6.00	5.80
1070x	(C.U.)	(?)	19.50	14.00	*71.79*	5.60	5.30	*29.17*	*28.34*	4.90	5.00	*25.52*	*26.74*	8.70	8.40	*45.31*	*44.92*	19.20	18.70	(?)	(?)	4.6	9.4	6.10	6.10
8.4, 1895-96	(C.U.)	(?)	19.90	14.30	*71.86*	5.45	5.30	*28.38*	*27.39*	5.75	5.50	*29.95*	*28.42*	8.00	8.55	*41.67*	*44.18*	19.20	19.35	18.25	18.55	5.2	10.5	6.50	6.75
581	(C.U.)	United States	19.40	14.00	*72.16*	5.30	(?)	*27.46*	(?)	5.70	(?)	*29.53*	(?)	8.30	7.50	*43.01*	(?)	19.30	(?)	(?)	17.40	5.0	(?)	6.45	5.95
36.3, 1895-96	(C.U.)	(?)	19.40	14.00	*72.16*	(?)	5.30	(?)	*28.65*	(?)	5.40	(?)	*29.19*	8.60	7.80	(?)	*42.16*	(?)	18.50	(?)	(?)	4.8	9.7	6.90	6.60
29.4, 1896-97	(C.U.)	(?)	19.90	14.40	*72.36*	5.40	5.40	*27.98*	*28.72*	5.60	5.30	*29.02*	*28.19*	8.30	8.10	*43.01*	*43.08*	19.30	18.80	(?)	(?)	5.3	10.3	6.60	6.20
	(C.U.)	(?)	18.70	13.60	*72.73*	5.10	5.10	*27.06*	*26.91*	5.10	5.20	*27.06*	*27.44*	8.65	8.65	*45.89*	*45.65*	18.85	18.95	(?)	(?)	5.1	9.9	6.95	6.95
23.1, 1898-99	(C.U.)	United States	19.40	14.15	*72.94*	5.35	5.10	*28.45*	*26.42*	5.75	5.85	*30.58*	*30.31*	7.70	8.35	*40.96*	*43.26*	18.80	19.30	(?)	(?)	5.2	9.9	6.15	5.90
1108x	(C.U.)	(?)	19.60	14.30	*72.96*	5.40	5.25	*29.03*	*27.56*	5.65	5.55	*30.37*	*29.13*	7.55	8.25	*40.59*	*43.31*	18.60	19.05	17.45	17.85	5.2	10.3	6.05	6.30
1082x	(C.U.)	(?)	18.70	13.65	*73.00*	(?)	4.80	(?)	*25.67*	5.60	5.60	(?)	*29.95*	7.80	8.30	(?)	*44.38*	(?)	18.70	16.75	17.10	5.0	10.0	6.20	6.30
32.1, 1895-96	(C.U.)	Ireland	18.75	13.70	*73.06*	5.40	5.10	*29.92*	*28.17*	5.45	5.45	*30.19*	*30.11*	7.20	7.55	*39.89*	*41.71*	18.05	18.10	(?)	(?)	5.1	9.3	5.85	5.90
609	(C.U.)	Scotland	19.25	14.10	*73.25*	5.20	5.45	*27.22*	*27.74*	5.25	5.55	*27.48*	*28.24*	8.65	8.65	*45.29*	*44.02*	19.10	19.65	18.00	18.10	4.8	10.4	6.65	6.65
1103x	(C.U.)	(?)	19.40	14.25	*73.45*	(?)	5.50	(?)	*28.49*	(?)	5.75	(?)	*29.79*	7.90	8.05	(?)	*41.71*	(?)	19.30	(?)	(?)	5.2	(?)	6.50	6.40
3.4, 1896-97	(C.U.)	United States	18.00	13.30	*73.89*	4.70	4.55	*26.55*	*25.71*	5.00	5.00	*28.24*	*28.24*	8.00	8.15	*45.19*	*46.04*	17.70	17.70	16.60	16.50	4.7	9.3	6.20	6.20
689	(C.U.)	.....do.....	18.80	13.90	*73.94*	5.05	(?)	*27.29*	(?)	6.20	6.20	*33.51*	(?)	7.25	7.40	*39.19*	(?)	18.50	(?)	17.35	17.50	5.3	9.6	5.90	5.80
17.4, 1895-96	(C.U.)	(?)	19.40	14.30	*74.09*	5.30	5.35	*28.34*	*28.53*	5.70	5.70	*30.48*	*30.40*	7.70	7.70	*41.18*	*41.07*	18.70	18.75	17.45	17.45	4.9	10.0	5.90	6.00
1016x	(C.U.)	(?)	18.70	13.90	*74.33*	5.30	5.10	*27.89*	*26.84*	5.90	5.80	*31.05*	*30.53*	7.80	8.10	*41.05*	*42.63*	19.00	19.00	17.05	(?)	4.9	9.8	6.45	6.00
																				(8)	(8)	(20)	(17)	(20)	(20)
Average (14)[b]			19.4	14.0	*72.3*	5.31	5.23	*28.1*	*27.4*	5.49	5.48	*29.0*	*28.8*	8.10	8.32	*42.9*	*43.8*	18.90	19.04	17.53	17.69	5.06	9.9	6.34	6.25
Minimum (14)			18.0	13.3	*69.4*	4.7	4.5	*26.5*	*25.7*	4.9	5.0	*25.5*	*26.7*	7.2	7.5	*39.9*	*41.1*	17.7	17.7	16.6	16.5	4.6	9.3	5.8	5.8
Maximum (14)			20.4	14.4	*74.3*	5.6	5.8	*29.9*	*28.7*	5.9	5.8	*31.1*	*30.5*	8.6	9.0	*45.9*	*46.0*	19.7	20.3	18.4	18.5	5.3	10.7	6.9	6.9

[a] Medical department of Columbia University, New York City, Prof. Geo. S. Huntington's collection.
[b] Number of skulls in which all the fossæ could be measured.

Cranial fossæ (ventral). Adult males, whites, mesocephals (cephalic index 75.1 to 80.0).

No.	Collection.	Nationality.	Skull.			Anterior fossa.				Middle fossa.				Posterior fossa, cerebral part.				Sum of the lengths of the fossæ.		Skull.				Length of posterior fossa, cerebellar portion.	
			Diameter antero-posterior maximum.	Diameter lateral maximum.	Cephalic index	Length.		Index.		Length.		Index.		Length.		Index.				Diameter antero-posterior maximum, ventrally.		Foramen cæcum to anterior border of pituitary fossa.	Breadth maximum of frontal region, ventrally.		
						Right.	Left.	Right	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.			Right.	Left.
			cm.	cm.		cm.	cm.			cm.	cm.			cm.	cm.			cm.	cm.	cm.	cm.	cm.	cm.	cm.	cm.
1357x	(C. U.)	(?)	18.55	13.95	75.20	5.15	5.05	26.82	27.15	5.75	5.55	29.95	29.84	8.30	8.00	43.23	43.01	19.20	18.60	17.55	17.25	4.8	10.5	6.40	6.35
1.5, 1894–95	(C. U.)	Italy	18.70	14.10	75.40	5.05	(?)	27.59	(?)	4.90	5.00	26.77	(?)	8.35	8.50	45.63	(?)	18.30	(?)	(?)	(?)	5.0	10.2	6.50	6.60
1095x	(C. U.)	(?)	18.85	14.35	76.13	(?)	5.15	(?)	27.99	(?)	5.45	(?)	29.62	7.90	7.80	(?)	42.39	(?)	18.40	17.00	17.10	4.7	(?)	6.00	5.95
1105x	(C. U.)	(?)	18.70	14.30	76.47	5.30	4.55	28.04	24.93	5.70	5.70	30.16	31.23	7.90	8.00	41.79	43.84	18.90	18.25	17.65	17.15	5.0	10.0	6.40	6.30
10.4, 1895–96	(C. U.)	(?)	19.35	14.80	76.48	5.30	5.20	28.05	27.08	5.60	5.60	29.63	29.16	8.00	8.40	42.33	43.75	18.90	19.20	(?)	(?)	5.0	10.6	6.55	6.30
1079x	(C. U.)	(?)	18.60	14.35	77.15	4.90	5.05	26.56	26.65	5.70	5.80	30.89	30.67	7.85	8.10	42.55	42.74	18.45	18.95	17.15	17.20	4.5	10.0	6.35	6.35
623	(C. U.)	United States	18.40	14.20	77.17	(?)	4.95	(?)	26.76	5.60	5.50	(?)	29.73	7.70	8.05	(?)	43.51	(?)	18.50	16.65	17.10	5.0	10.7	6.40	6.30
344	(C. U.)	Ireland	18.20	14.10	77.47	5.50	5.50	29.49	28.28	5.40	5.80	28.96	29.82	7.75	8.15	41.56	41.90	18.65	19.45	17.05	(?)	5.4	10.7	6.20	6.25
1073x	(C. U.)	(?)	19.35	15.00	77.52	5.05	5.05	25.97	25.83	5.55	5.55	28.53	28.39	8.85	8.95	45.51	45.78	19.45	19.55	18.35	18.45	4.5	10.9	6.70	6.65
7.4, 1895–96	(C. U.)	United States	18.80	14.60	77.66	5.30	4.90	28.80	(?)	6.00	(?)	32.61	(?)	7.10	(?)	38.59	(?)	18.40	(?)	17.15	17.10	5.0	(?)	5.75	(?)
7.1, 1896–97	(C. U.)	Ireland	18.40	14.30	77.72	(?)	4.90	(?)	26.20	(?)	5.70	(?)	30.48	7.55	8.10	(?)	43.32	(?)	18.70	(?)	(?)	4.7	10.5	6.00	6.30
4.5, 1895–96	(C. U.)	(?)	18.50	14.40	77.84	5.20	5.15	28.57	27.54	4.80	4.85	26.37	25.93	8.20	8.70	45.05	46.52	18.20	18.70	17.05	17.35	4.7	9.8	6.40	6.85
1088x	(C. U.)	(?)	18.25	14.30	78.35	5.00	(?)	28.17	(?)	5.65	6.00	31.83	(?)	7.10	7.50	40.00	(?)	17.75	(?)	(?)	(?)	5.1	(?)	6.00	5.95
35.3, 1895–96	(C. U.)	(?)	19.00	14.90	78.42	5.50	5.30	29.57	28.19	5.60	5.40	30.11	28.72	7.50	8.10	40.32	43.09	18.60	18.80	16.95	17.00	4.6	10.5	5.90	6.20
799	(C. U.)	Italy	18.20	14.30	78.57	5.10	5.45	28.89	29.78	5.60	5.50	31.73	30.06	6.95	7.35	39.37	40.16	17.65	18.30	16.25	16.80	5.3	10.4	6.00	6.10
	(C. U.)	(?)	19.15	15.05	78.59	5.10	4.75	26.91	25.68	5.30	5.20	27.97	28.11	8.55	8.55	45.12	46.22	18.95	18.50	17.50	17.40	4.7	10.9	6.75	6.50
54.4, 1896–97	(C. U.)	(?)	18.80	14.80	78.72	4.95	(?)	27.73	(?)	5.70	(?)	31.93	(?)	7.20	7.80	40.34	(?)	17.85	(?)	(?)	(?)	4.8	9.6	6.00	6.00
1099x	(C. U.)	(?)	18.60	14.65	78.76	5.30	4.95	28.12	27.05	5.80	5.70	30.77	31.15	7.75	7.65	41.11	41.80	18.85	18.30	17.50	17.30	5.1	10.3	6.15	6.50
3.2, 1895–96	(C. U.)	(?)	17.80	14.10	79.21	5.00	(?)	27.93	(?)	5.40	(?)	30.17	(?)	7.50	7.50	41.89	(?)	17.90	(?)	16.40	(?)	5.0	10.7	6.05	5.90
803	(C. U.)	(?)	19.20	15.35	79.95	(?)	5.30	(?)	28.04	(?)	6.10	(?)	32.27	7.85	7.50	(?)	39.68	(?)	18.90	(?)	(?)	5.1	(?)	6.15	5.85
																				(12)	(12)	(20)	(16)	(20)	(19)
Average (11)[a]			18.7	14.5	77.5	5.22	5.09	27.9	27.10	5.53	5.51	29.5	29.3	7.96	8.18	42.6	43.6	18.71	18.78	17.23	17.27	4.9	10.4	6.23	6.27
Minimum (11)			18.2	13.9	75.2	4.9	4.5	25.9	24.9	4.8	4.8	26.4	25.9	6.9	7.3	39.4	40.2	17.6	18.2	16.2	16.8	4.5	9.6	5.7	5.8
Maximum (11)			19.3	15.0	78.8	5.5	5.5	29.5	29.8	5.8	5.8	31.7	31.2	8.8	8.9	45.5	46.5	19.4	19.5	18.3	18.4	5.3	10.9	6.7	6.8

[a] Number of skulls in which all the fossæ could be measured.

Cranial fossæ (ventral). Adult males, whites, brachycephals (cephalic index 80.1 and above).

No.	Collection.	Nationality.	Skull.			Anterior fossa.				Middle fossa.				Posterior fossa, cerebral part.				Sum of the lengths of the fossæ.		Skull.		Foramen cæcum to anterior border of pituitary fossa.	Breadth maximum of frontal region, ventrally.	Length of posterior fossa, cerebellar portion.	
			Diameter antero-posterior maximum.	Diameter lateral maximum.	Cephalic index.	Length.		Index.		Length.		Index.		Length.		Index.				Diameter antero-posterior maximum, ventrally.					
						Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.			Right.	Left.			Right.	Left.
			cm.	*cm.*		*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
26,2,1895–96	(C. U.)	(?)	18.00	14.40	*80.00*	(?)	4.55	(?)	*25.92*	4.50	4.80	(?)	*27.35*	8.20	8.20	(?)	*46.72*	(?)	17.55	(?)	(?)	4.2	(?)	6.80	6.80
383	(C. U.)	Italy	18.30	14.65	*80.05*	4.50	(?)	*26.08*	(?)	5.55	5.90	*32.17*	(?)	7.20	7.65	*41.74*	(?)	17.25	(?)	(?)	(?)	5.0	10.6	6.05	5.75
1086x	(C. U.)	(?)	19.60	15.75	*80.35*	4.80	(?)	*25.60*	(?)	5.50	5.60	*29.33*	(?)	8.45	8.45	*45.07*	(?)	18.75	(?)	17.80	17.55	5.0	10.5	6.50	6.50
	(C. U.)	(?)	18.80	15.15	*80.58*	5.05	5.05	*27.22*	*26.16*	5.80	5.70	*31.27*	*29.53*	7.70	8.55	*41.51*	*44.30*	18.55	19.30	17.20	17.45	5.1	10.6	6.50	6.60
1107x	(C. U.)	(?)	17.80	14.35	*80.62*	4.80	4.80	*26.16*	*26.57*	5.60	5.40	*30.52*	*29.83*	7.95	7.90	*43.32*	*43.65*	18.35	18.10	16.65	16.35	5.0	10.5	6.20	6.20
790	(C. U.)	Italy	17.30	14.20	*82.08*	5.00	(?)	*27.93*	(?)	5.60	(?)	*31.28*	(?)	7.30	7.50	*40.78*	(?)	17.90	(?)	(?)	(?)	4.2	(?)	5.70	5.95
1355	(C. U.)	(?)	18.20	14.95	*82.14*	5.35	5.25	*29.72*	*28.92*	5.40	5.40	*30.00*	*29.75*	7.25	7.50	*40.28*	*41.32*	18.00	18.15	16.65	16.70	5.1	10.7	6.20	6.45
878	(C. U.)	Italy	18.35	15.15	*82.56*	5.10	4.95	*27.64*	*26.90*	5.85	5.85	*31.77*	*31.79*	7.50	7.60	*40.65*	*41.30*	18.45	18.40	16.40	16.60	5.2	10.0	6.10	5.90
1080x	(C. U.)	(?)	18.25	15.10	*82.74*	4.90	4.60	*26.13*	*24.73*	5.65	5.60	*30.13*	*30.11*	8.20	8.40	*43.73*	*45.16*	18.75	18.60	17.20	17.10	4.7	11.3	6.30	6.25
1087	(C. U.)	(?)	18.00	15.00	*83.33*	(?)	5.45	(?)	*29.46*	5.30	5.30	(?)	*28.65*	7.50	7.75	(?)	*41.89*	(?)	18.50	(?)	(?)	5.2	(?)	6.50	6.25
1100x	(C. U.)	(?)	17.20	14.35	*83.43*	4.95	4.90	*28.28*	*27.37*	5.70	5.45	*32.57*	*30.45*	6.85	7.55	*39.14*	*42.18*	17.50	17.90	15.70	15.95	5.3	10.7	5.80	5.80
	(C. U.)	(?)	18.75	15.70	*83.73*	5.80	5.70	*30.13*	*29.46*	5.80	5.90	*30.13*	*30.49*	7.65	7.75	*39.74*	*40.05*	19.25	19.35	(?)	(?)	5.3	11.0	6.35	6.40
1351x	(C. U.)	(?)	18.15	15.30	*84.30*	4.70	4.80	*25.96*	*26.09*	5.70	5.70	*31.49*	*30.98*	7.70	7.90	*42.55*	*42.93*	18.10	18.40	16.80	16.90	4.8	11.1	6.40	6.40
1096x	(C. U.)	(?)	19.50	16.50	*84.62*	5.00	4.95	*26.59*	*26.05*	6.00	6.00	*31.92*	*31.58*	7.80	8.05	*41.49*	*42.47*	18.80	19.00	(?)	(?)	4.5	11.8	6.55	6.70
651	(C. U.)	Germany	17.80	15.30	*85.96*	4.85	(?)	*26.14*	(?)	5.70	(?)	*30.73*	(?)	8.00	(?)	*43.12*	(?)	18.55	(?)	(?)	(?)	4.7	(?)	6.45	(?)
	(C. U.)	(?)	17.40	15.00	*86.21*	4.75	4.45	*26.91*	*25.28*	5.60	5.50	*31.73*	*31.25*	7.30	7.65	*41.36*	*43.46*	17.65	17.60	15.80	15.75	4.6	10.6	6.30	6.35
2,5,1894–95	(C. U.)	(?)	17.90	15.45	*86.31*	4.80	4.85	*26.37*	*26.72*	5.80	5.60	*31.87*	*30.85*	7.60	7.70	*41.76*	*42.42*	18.20	18.15	(?)	(?)	4.3	10.4	6.10	6.10
726	(C. U.)	United States	18.60	16.10	*86.56*	(?)	4.70	(?)	*25.61*	(?)	5.75	(?)	*31.33*	7.80	7.90	(?)	*43.05*	(?)	18.35	(?)	(?)	4.8	11.4	6.55	6.60
107	(C. U.)	Germany	17.40	15.55	*89.37*	(?)	4.60	(?)	*25.69*	(?)	5.60	(?)	*31.28*	7.60	7.70	(?)	*43.02*	(?)	17.90	(?)	(?)	4.4	(?)	5.95	5.70
25,4,1896–97	(C. U.)	United States	18.70	16.80	*89.84*	5.20	(?)	*27.51*	(?)	6.30	(?)	*33.34*	(?)	7.40	8.00	*39.15*	(?)	18.90	(?)	17.10	(?)	5.0	11.5	6.40	6.85
																				(9)	(9)	(20)	(15)	(20)	(19)
Average (11)[a]			18.2	15.2	*83.4*	5.02	4.94	*27.7*	*26.8*	5.54	5.65	*30.5*	*30.6*	7.59	7.87	*41.90*	*42.6*	18.15	18.45	16.69	16.71	4.8	10.8	6.28	6.29
Minimum (11)			17.2	14.3	*80.6*	4.7	4.4	*25.9*	*25.3*	5.4	5.4	*30.0*	*29.5*	6.8	7.5	*39.1*	*40.0*	17.6	17.6	15.7	15.7	4.2	10.0	5.7	5.7
Maximum (11)			19.5	16.5	*86.3*	5.8	5.7	*30.1*	*29.5*	6.0	6.0	*32.6*	*31.8*	8.2	8.5	*43.7*	*45.20*	19.2	19.3	17.8	17.5	5.3	11.8	6.8	6.8

[a] Number of skulls in which all the fossæ could be measured.

Cranial fossæ (ventral). Adult females, whites, dolichocephals.

No.	Collection.	Nationality.	Skull.			Anterior fossa.				Middle fossa.				Posterior fossa, cerebral part.				Sum of the lengths of the fossæ.		Skull.		Foramen cœcum to anterior border of pituitary fossa.	Breadth maximum of frontal region, ventrally.	Length of posterior fossa, cerebellar portion.	
			Diameter antero-posterior maximum.	Diameter lateral maximum.	Cephalic index.	Length.		Index.		Length.		Index.		Length.		Index.				Diameter antero-posterior maximum, ventrally.					
						Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.			Right.	Left.
			cm.	*cm.*		*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
703	(C. U.)	Italy	17.80	12.50	*70.22*	5.20	(?)	*29.72*	(?)	5.25	(5.45)	*30.00*	(?)	7.05	(7.70)	*40.29*	(?)	17.50	(?)	16.25	(?)	4.9	9.1	5.80	6.00
4.2, 1895–96	(C. U.)	(?)	17.85	12.90	*72.27*	4.60	4.40	*26.51*	*25.07*	5.35	5.20	*30.84*	*29.63*	7.40	7.95	*42.65*	*45.29*	17.35	17.55	16.35	16.70	4.6	9.8	5.95	6.15
1104x	(C. U.)	(?)	18.35	13.40	*73.02*	(?)	4.80	(?)	*27.12*	(?)	5.10	(?)	*28.81*	(7.40)	7.80	(?)	*44.07*	(?)	17.70	16.50	16.75	4.8	9.4	5.85	5.90
6.5, 1895–96	(C. U.)	(?)	16.75	12.30	*73.43*	5.00	4.90	*29.07*	*28.48*	5.00	4.80	*29.07*	*27.91*	7.20	7.50	*41.86*	*43.60*	17.20	17.20	15.20	15.50	4.8	9.3	5.60	5.70
1089x	(C. U.)	(?)	18.00	13.25	*73.61*	4.90	4.85	*28.32*	*27.56*	5.05	5.15	*29.19*	*29.26*	7.35	7.60	*42.48*	*43.18*	17.30	17.60	16.35	16.50	4.6	9.0	5.50	5.70
895	(C. U.)	(?)	18.60	13.70	*73.66*	5.00	5.00	*28.01*	*27.85*	5.05	5.00	*28.29*	*27.85*	7.80	7.95	*43.69*	*44.29*	17.85	17.95	17.10	17.10	4.6	(?)	6.15	5.95
X	(C. U.)	(?)	17.85	13.25	*74.23*	4.85	4.75	*28.03*	*26.61*	5.20	5.20	*30.05*	*29.13*	7.25	7.90	*41.92*	*44.26*	17.30	17.85	16.50	16.75	(?)	(?)	5.95	5.95
21.2, 1895–96	(C. U.)	(?)	17.50	13.05	*74.57*	(?)	4.90	(?)	*27.68*	(5.20)	5.30	(?)	*29.94*	(7.55)	7.50	(?)	*42.37*	(?)	17.70	16.45	16.65	4.8	(?)	6.10	5.75
1102x	(C. U.)	(?)	18.30	13.65	*74.59*	5.60	(?)	*30.11*	(?)	5.70	(?)	*30.65*	(?)	7.30	(7.15)	*39.25*	(?)	18.60	(?)	16.65	(?)	(?)	(?)	5.85	5.50
37.5, 1894-95	(C. U.)	Ireland	18.50	13.85	*74.86*	5.30	(?)	*29.61*	(?)	5.05	(4.95)	*28.21*	(?)	7.55	(7.80)	*42.18*	(?)	17.90	(?)	(?)	16.60	5.1	9.3	5.75	5.85
Average (5)[a]			17.8	13.1	*73.4*	4.87	4.78	*28.0*	*27.1*	5.13	5.07	*29.5*	*28.6*	7.40	7.78	*42.5*	*44.1*	17.40	17.63	16.3	16.5	(8) 4.8	(6) 9.3	(10) 5.85	(10) 5.84
Minimum (5)			16.7	12.3	*72.3*	4.6	4.4	*26.5*	*25.1*	5.0	4.8	*28.3*	*27.8*	7.2	7.5	*41.9*	*43.2*	17.2	17.2	15.2	15.5	4.6	9.0	5.5	5.5
Maximum (5)			18.6	13.7	*74.2*	5.0	5.0	*29.1*	*28.5*	5.3	5.2	*30.1*	*29.6*	7.8	7.9	*43.7*	*45.3*	17.8	17.9	17.1	17.1	5.1	9.8	6.1	6.1

[a] Number of skulls in which all the fossæ could be measured.

Cranial fossæ (ventral). Adult females, whites, mesocephals.

No.	Collection.	Nationality.	Skull.			Anterior fossa.				Middle fossa.				Posterior fossa, cerebral part.				Sum of the lengths of the fossæ.		Skull.		Foramen cœcum to anterior border of pituitary fossa.	Breadth maximum of frontal region, ventrally.	Length of posterior fossa, cerebellar portion.	
			Diameter antero-posterior maximum.	Diameter lateral maximum.	Cephalic index.	Length.		Index.		Length.		Index.		Length.		Index.				Diameter antero-posterior maximum, ventrally.					
						Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.			Right.	Left.
			cm.	*cm.*		*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
15	(C. U.)	United States	18.20	13.70	*75.27*	(?)	5.25	(?)	*28.37*	5.10	5.10	(?)	*27.56*	7.90	8.15	(?)	*44.59*	(?)	18.5	(?)	(?)	4.5	10.0	6.25	6.20
21.4, 1898–99	(C. U.)	Ireland	18.35	13.85	*75.48*	5.20	5.05	*29.29*	*27.82*	5.40	5.40	*30.42*	*29.75*	7.15	7.70	*40.28*	*42.42*	17.75	18.15	16.40	16.80	5.4	10.1	5.90	5.90
41.1, 1895–96	(C. U.)	(?)	17.20	13.00	*75.58*	4.60	(?)	*27.37*	(?)	4.80	(?)	*28.57*	(?)	7.40	(?)	*44.05*	(?)	16.80	(?)	15.35	(?)	4.6	8.6	5.70	(?)
41.3, 1895–96	(C. U.)	Italy	18.00	13.90	*77.22*	4.90	(?)	*27.61*	(?)	5.30	(?)	*29.86*	(?)	7.55	7.90	*42.53*	(?)	17.75	(?)	16.30	(?)	4.0	9.6	6.30	6.40
1101 χ	(C. U.)	(?)	18.10	14.00	*77.35*	(?)	5.45	(?)	*29.46*	(?)	5.15	(?)	*27.84*	7.40	7.90	(?)	*42.70*	(?)	18.50	(?)	17.30	5.1	9.8	6.00	6.00
671	(C. U.)	United States	17.95	13.90	*74.43*	4.90	4.85	*27.68*	*27.09*	5.30	5.15	*29.94*	*28.77*	7.50	7.90	*42.37*	*44.14*	17.70	17.90	16.15	16.15	4.8	9.3	6.15	6.20
20.9, 1898–99	(C. U.)	do	18.20	14.10	*77.47*	4.75	4.75	*26.46*	*26.24*	4.90	4.95	*27.29*	*27.35*	8.30	8.40	*46.24*	*46.41*	17.95	18.10	17.15	16.95	4.8	9.9	6.70	6.70
1268	(C. U.)	(?)	17.90	14.00	*78.21*	5.05	4.85	*27.42*	*27.47*	5.00	4.90	*27.70*	*27.76*	8.00	7.90	*44.32*	*44.76*	18.05	17.65	16.65	16.40	(?)	(?)	6.20	6.15
796	(C. U.)	United States	17.00	13.60	*80.00*	5.20	5.10	*29.13*	*28.73*	5.75	5.35	*32.21*	*30.14*	6.90	7.30	*38.65*	*41.12*	17.85	17.75	16.05	16.05	4.9	9.7	5.70	5.75
	(C. U.)	(?)	17.25	13.80	*80.00*	5.20	5.05	*28.73*	*27.75*	5.25	5.50	*29.01*	*30.22*	7.65	7.65	*42.26*	*42.03*	18.10	18.20	16.20	16.35	(?)	(?)	6.20	5.80
Average (6)[a]			17.8	13.9	*78.1*	5.05	4.94	*28.2*	*27.5*	5.27	5.21	*29.4*	*29.0*	7.58	7.81	*42.4*	*43.5*	17.90	17.96	16.4	16.5	4.8	9.6	6.16	6.12
Minimum (6)			17.0	13.6	*75.5*	4.7	4.7	*26.5*	*26.2*	4.9	4.9	*27.3*	*27.3*	6.9	7.3	*38.6*	*41.1*	17.7	17.6	16.0	16.0	4.0	8.6	5.7	5.7
Maximum (6)			18.3	14.0	*80.0*	5.2	5.1	*29.3*	*28.7*	5.7	5.5	*32.2*	*30.2*	8.3	8.4	*46.2*	*46.4*	18.1	18.2	17.1	16.9	5.4	10.1	6.7	6.7
																						(8)	(8)	(9)	(9)

[a] Number of skulls in which all the fossæ could be measured.

Cranial fossæ (ventral). Adult females, whites, brachycephals.

No.	Collection.	Nationality.	Skull.			Anterior fossa.				Middle fossa.				Posterior fossa, cerebral part.				Sum of the lengths of the fossæ.		Skull.		Foramen cæcum (to anterior border of pituitary fossa.	Breadth maximum of frontal region, ventrally.	Length of posterior fossa, cerebellar portion.	
			Diameter antero-posterior maximum.	Diameter lateral maximum.	Cephalic index.	Length.		Index.		Length.		Index.		Length.		Index.				Diameter antero-posterior maximum, ventrally.					
						Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.			Right.	Left.
			cm.	*cm.*		*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
1091 χ	(C. U.)	(?)	17.25	13.85	*80.29*	5.15	5.05	*29.17*	*28.61*	5.20	5.20	*29.46*	*29.46*	7.30	7.40	*41.36*	*41.92*	17.65	17.65	16.15	16.25	4.6	10.2	5.60	5.60
9.1, 1898–99	(C. U.)	(?)	17.40	14.00	*80.46*	4.65	(?)	*26.65*	(?)	5.40	(?)	*30.94*	(?)	7.40	(?)	*42.41*	(?)	17.45	(?)	16.25	(?)	4.4	(?)	6.10	(?)
10.3, 1896–97	(C. U.)	Ireland	18.00	14.50	*80.56*	4.60	4.60	*26.36*	*26.06*	5.10	5.00	*29.22*	*28.33*	7.75	8.05	*44.41*	*45.61*	17.45	17.65	15.85	16.30	4.7	9.2	6.35	6.25
182	(C. U.)	Germany	17.05	13.80	*80.94*	4.75	4.40	*28.02*	*25.88*	4.80	4.80	*28.32*	*28.24*	7.40	7.80	*43.65*	*40.00*	16.95	17.00	15.70	15.60	4.3	9.6	6.30	6.20
39.2, 1899–1900	(C. U.)	(?)	17.15	14.00	*81.63*	5.00	5.00	*28.01*	*28.17*	5.25	5.15	*29.41*	*29.01*	7.60	7.60	*42.58*	*42.82*	17.85	17.75	(?)	(?)	4.7	10.5	6.10	6.00
1360	(C. U.)	(?)	16.75	13.85	*82.69*	4.75	4.85	*26.98*	*27.71*	5.00	5.20	*28.41*	*29.71*	7.85	7.45	*44.61*	*42.58*	17.60	17.50	15.85	15.60	(?)	(?)	6.40	6.15
654	(C. U.)	France	17.40	14.10	*82.76*	5.10	5.10	*28.81*	*28.89*	5.50	5.50	*31.07*	*31.16*	7.10	7.05	*40.11*	*39.94*	17.70	17.65	(?)	(?)	4.8	10.6	5.65	5.85
1098 χ	(C. U.)	(?)	17.00	14.25	*83.82*	(?)	5.30	(?)	*29.20*	(?)	5.55	(?)	*30.58*	7.05	7.30	(?)	*40.22*	(?)	18.15	(?)	(?)	5.2	(?)	5.75	5.95
42.5, 1894–95	(C. U.)	(?)	17.20	15.35	*89.24*	(?)	4.45	(?)	*24.86*	(?)	5.55	(?)	*31.01*	6.80	7.90	(?)	*44.13*	(?)	17.90	(?)	(?)	(?)	(?)	5.50	6.05
483	(C. U.)	Ireland	17.80	(?)	(*a*)	(?)	4.70	(?)	*26.84*	(?)	5.20	(?)	*29.71*	(?)	7.60	(?)	*43.43*	(?)	17.50	(?)	(?)	4.9	(?)	(?)	5 80
Average (6)[b]			17.3	14.1	*81.5*	4.8	4.83	*27.9*	*27.5*	5.14	5.14	*29.3*	*29.3*	7.50	7.56	*42.8*	*43.2*	17.53	17.53	(4) 15.89	(4) 15.91	(8) 4.7	(5) 10.0	(9) 5.97	(9) 5.98
Minimum (6)			16.7	13.8	*80.2*	4.69	4.4	*26.4*	*25.9*	4.8	1.8	*28.3*	*28.2*	7.1	7.05	*40.1*	*39.9*	16.9	17.0	15.7	15.6	4.3	9.2	5.5	5.6
Maximum (6)			18.0	14.5	*82.8*	5.1	5.1	*29.2*	*28.9*	5.5	5.5	*31.1*	*31.2*	7.8	8.05	*44.6*	*45.6*	17.8	17.7	16.1	16.3	5.2	10.6	6.4	6.2

[a] Moderate brachycephals.

[b] Number of skulls in which all the fossæ could be measured.

Cranial fossæ (ventral). Adult males, Indians, dolichocephals.

No.	Collection.	Locality.	Skull.			Anterior fossa.				Middle fossa.				Posterior fossa, cerebral part.				Sum of the lengths of the fossæ.		Skull.				Length of posterior fossa, cerebellar portion.	
			Diameter antero-posterior maximum.	Diameter lateral maximum.	Cephalic index.	Length.		Index.		Length.		Index.		Length.		Index.				Diameter antero-posterior maximum, ventrally.		Foramen cœcum to anterior border of pituitary fossa.	Breadth maximum of frontal region, ventrally.		
						Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.			Right.	Left.
			cm.	*cm.*		*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
242.002	National Museum.	Santa Cruz Island, Cal.	18.50	13.25	*71.62*	4.20	4.50	*23.26*	*25.49*	5.70	5.50	*31.57*	*31.16*	8.15	7.65	*45.17*	*43.35*	18.05	17.65	16.75	16.30	4.7	9.6	6.50	6.10
242.006	do	do	18.80	13.70	*72.87*	4.70	4.75	*25.33*	*25.33*	5.50	5.20	*29.65*	*27.73*	8.35	8.80	*45.02*	*44.94*	18.50	18.75	17.15	17.25	4.3	10.1	6.70	6.70
241.969	do	do	18.90	13.80	*73.02*	5.60	5.25	*29.71*	*27.92*	5.50	5.30	*29.17*	*28.19*	7.75	8.25	*41.42*	*43.89*	18.85	18.80	17.60	17.70	5.0	10.2	6.40	6.90
241.961	do	do	17.90	13.15	*73.46*	4.65	4.50	*26.72*	*25.42*	5.10	5.00	*29.31*	*28.25*	7.65	8.20	*43.97*	*46.33*	17.40	17.70	15.95	16.30	4.6	9.6	6.30	6.30
242.361	do	Peru	18.40	13.60	*73.91*	4.60	4.45	*25.34*	*24.86*	5.15	5.20	*28.37*	*29.05*	8.40	8.25	*46.29*	*46.09*	18.15	17.90	17.05	17.15	4.3	(?)	6.50	6.20
242.362	do	do	17.70	13.10	*74.01*	4.85	4.80	*27.87*	*27.17*	5.30	5.10	*30.46*	*28.81*	7.25	7.80	*41.67*	*44.02*	17.40	17.70	16.05	16.35	4.5	(?)	6.10	5.90
241.945	do	Santa Cruz Island, Cal.	18.15	13.45	*74.10*	4.80	5.00	*26.59*	*27.24*	5.10	5.10	*28.25*	*27.79*	8.15	8.25	*45.16*	*44.97*	18.05	18.35	16.40	16.30	4.6	9.4	6.45	6.30
241.947	do	do	18.35	13.60	*74.12*	4.65	4.65	*25.91*	*25.34*	5.30	5.10	*29.52*	*27.79*	8.00	8.60	*44.57*	*46.87*	17.95	18.35	16.50	16.80	4.5	9.3	6.50	6.25
242.363	do	do	18.45	13.80	*74.79*	4.60	4.45	*26.13*	*24.72*	5.70	5.70	*32.38*	*31.67*	7.30	7.85	*41.49*	*43.61*	17.60	18.00	16.20	16.50	4.8	(?)	6.10	5.85
242.364	do	do	17.90	13.40	*74.86*	4.25	4.10	*24.29*	*23.36*	5.00	4.65	*28.57*	*26.49*	8.25	8.80	*47.14*	*50.15*	17.50	17.55	16.60	16.60	4.1	(?)	6.50	6.80
Average (10)[a]			18.3	13.5	*73.7*	4.69	4.64	*26.1*	*25.7*	5.33	5.18	*29.7*	*28.7*	7.92	8.24	*44.1*	*45.7*	17.94	18.07	16.6	16.7	4.5	9.7	6.40	6.33
Minimum (10)			17.7	13.1	*71.6*	4.2	4.1	*23.3*	*23.4*	5.0	4.6	*28.2*	*26.5*	7.2	7.6	*41.1*	*43.3*	17.1	17.5	15.9	16.3	4.1	9.4	6.1	5.8
Maximum (10)			18.9	13.8	*74.9*	5.6	5.2	*29.7*	*27.9*	5.7	5.7	*32.4*	*31.7*	8.4	8.8	*47.1*	*50.1*	18.8	18.8	17.6	17.7	5.0	10.2	6.7	6.9

[a] Number of skulls in which all the fossæ could be measured.

Cranial fossæ (ventral). Adult males, Indians, brachycephals.

No.	Collection.	Locality.	Skull.			Anterior fossa.				Middle fossa.				Posterior fossa, cerebral part.				Sum of the lengths of the fossæ.		Skull.		Foramen cœcum to anterior border of pituitary fossa.	Breadth maximum of frontal region, ventrally.	Length of posterior fossa cerebellar portion.	
			Diameter antero-posterior maximum.	Diameter lateral maximum.	Cephalic index.	Length.		Index.		Length.		Index.		Length.		Index.				Diameter antero-posterior maximum, ventrally.					
						Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.			Right.	Left.
			cm.	*cm.*		*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
242.365	National Museum	Peru	17.00	14.20	*83.53*	4.70	4.45	*27.65*	*26.25*	5.20	5.20	*30.59*	*30.68*	7.10	7.30	*41.76*	*43.07*	17.00	16.95	15.60	15.50	4.2	.....	5.90	5.80
242.366	.....do	.....do	16.30	13.80	*84.66*	4.55	4.55	*26.09*	*26.84*	5.40	5.40	*31.67*	*31.86*	7.10	7.00	*42.24*	*41.30*	17.05	16.95	15.00	15.00	4.2	.....	5.75	5.70
242.367	.....do	.....do	17.40	14.80	*85.06*	4.65	4.60	*25.54*	*25.27*	5.60	5.55	*30.76*	*30.49*	7.95	8.05	*43.70*	*44.24*	18.20	18.20	16.05	16.25	4.4	.....	6.65	6.55
242.368	.....do	.....do	17.40	14.80	*85.06*	4.70	4.60	*26.48*	*26.82*	5.45	5.00	*30.70*	*29.15*	7.60	7.55	*42.82*	*44.03*	17.75	17.15	15.80	15.80	4.5	11.1	6.20	6.35
242.369	.....do	.....do	17.40	14.80	*85.06*	4.55	4.65	*25.71*	*26.34*	5.30	5.30	*29.94*	*30.03*	7.85	7.70	*44.35*	*43.63*	17.70	17.65	16.00	16.10	4.4	.....	6.35	6.15
242.370	.....do	.....do	17.40	14.80	*85.06*	4.40	4.55	*25.07*	*27.00*	5.70	5.05	*32.47*	*29.97*	7.45	7.25	*42.46*	*43.03*	17.55	16.85	15.80	15.85	4.6	10.4	5.80	5.90
242.371	.....do	.....do	16.80	14.60	*86.90*	4.65	4.65	*27.76*	*27.59*	5.00	4.90	*29.85*	*29.08*	7.10	7.30	*42.39*	*43.03*	16.75	16.85	15.00	15.30	4.5	.....	5.50	5.40
242.372	.....do	.....do	16.80	14.80	*88.10*	4.35	4.10	*25.59*	*24.62*	5.30	5.30	*31.17*	*31.83*	7.35	7.25	*43.24*	*43.55*	17.00	16.65	15.10	15.20	4.4	10.9	5.85	5.45
242.373	.....do	.....do	16.30	14.40	*88.34*	4.65	4.55	*28.01*	*26.76*	5.50	5.35	*33.13*	*31.47*	6.65	7.10	*38.86*	*41.77*	16.80	17.00	14.10	14.50	4.4	.....	5.40	5.80
242.374	.....do	.....do	16.60	15.20	*91.57*	4.50	4.45	*26.47*	*26.18*	5.15	4.90	*30.29*	*28.82*	7.35	7.65	*43.24*	*45.00*	17.00	17.00	14.90	14.90	4.4	.....	5.90	6.00
	Average (10)[a]		16.9	14.6	*86.33*	4.57	4.52	*26.44*	*26.37*	5.36	5.19	*31.06*	*30.34*	7.35	7.41	*42.51*	*43.26*	17.28	17.12	15.33	15.44	4.4	10.8	5.93	5.91
	Minimum (10)		16.3	13.8	*83.53*	4.35	4.10	*25.07*	*24.62*	5.00	4.90	*29.85*	*29.08*	6.65	7.00	*38.86*	*41.30*	16.75	16.65	14.10	14.50	4.2	10.4	5.40	5.40
	Maximum (10)		17.4	15.2	*91.57*	4.70	4.65	*28.01*	*27.59*	5.70	5.55	*33.13*	*31.86*	7.95	8.05	*44.35*	*45.00*	18.20	18.20	16.05	16.25	4.6	11.1	6.65	6.55

[a] Number of skulls in which all the fossæ could be measured.

Cranial fossæ (ventral). Adult males, negroes (African and American), dolicho- to mesocephals.

No.	Collection.	Nationality.	Skull.			Anterior fossa.				Middle fossa.				Posterior fossa, cerebral part.				Sum of the lengths of the fossæ.		Skull.		Foramen cæcum to anterior border of pituitary fossa.	Breadth maximum of frontal region, ventrally.	Length of posterior fossa, cerebellar portion.	
			Diameter antero-posterior maximum.	Diameter lateral maximum.	Cephalic index.	Length.		Index.		Length.		Index.		Length.		Index.				Diameter antero-posterior maximum, ventrally.					
						Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.			Right.	Left.
			cm.	*cm.*		*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
980	(A. M. M.) [a]	American negro.	19.90	14.30	*71.86*	5.20	5.20	*27.51*	*27.22*	6.00	5.95	*31.74*	*31.15*	7.70	7.95	*40.74*	*41.62*	18.90	19.10	17.30	17.40	5.3	10.3	6.35	6.50
23.4, 1895-96	(C. U.)	do	18.40	13.40	*72.83*	(?)	4.70	(?)	*27.56*	5.00	4.70	(?)	*27.56*	7.55	7.65	(?)	*44.87*	(?)	17.05	(?)	(?)	4.4	8.9	5.65	5.80
1356	(C. U.)	American negro or mulatto.	18.20	13.30	*73.08*	4.90	5.00	*26.77*	*26.95*	5.30	5.20	*28.96*	*28.46*	8.10	8.35	*44.26*	*45.01*	18.30	18.55	16.80	16.80	5.1	10.6	6.20	6.40
2331	(A. M. M.)	do	19.00	13.90	*73.16*	5.05	5.05	*28.06*	*27.29*	5.20	5.20	*28.89*	*28.11*	7.75	8.25	*43.06*	*44.59*	18.00	18.50	16.95	17.20	4.8	10.3	6.05	6.20
3023	(A. M. M.)	Africanne-gro.	18.30	13.40	*73.22*	5.05	5.00	*28.06*	*27.70*	5.00	4.80	*27.78*	*26.59*	7.95	8.25	*44.17*	*45.71*	18.00	18.05	16.20	16.40	4.6	10.2	6.35	6.45
930	(C. U.)	American negro.	18.20	13.40	*73.63*	5.05	4.90	*30.24*	*27.37*	5.40	5.40	*32.33*	*30.17*	6.25	7.60	*37.42*	*42.46*	16.70	17.90	16.00	16.85	5.0	(?)	6.20	7.30
979	(A. M. M.)	do	19.00	14.00	*73.68*	5.30	5.20	*28.80*	*27.81*	5.40	5.25	*29.35*	*28.07*	7.70	8.25	*41.85*	*44.12*	18.40	18.70	17.20	17.40	4.9	10.5	6.20	6.30
12.4, 1896-97	(C. U.)	do	19.10	14.20	*74.35*	5.45	5.15	*28.91*	*26.62*	5.50	5.90	*29.18*	*30.49*	7.90	8.30	*41.91*	*42.89*	18.85	19.35	17.85	18.05	5.0	9.6	6.50	6.50
975	(A. M. M.)	do	18.65	14.10	*75.60*	5.00	5.00	*27.17*	*27.78*	5.70	5.50	*30.98*	*30.56*	7.70	7.50	*41.85*	*41.67*	18.40	18.00	16.40	16.30	4.8	10.6	6.15	6.20
3086	(A. M. M.)	Africanne-gro.	17.60	13.40	*75.71*	4.90	5.00	*27.37*	*27.47*	5.15	5.00	*28.77*	*27.47*	7.85	8.20	*43.85*	*45.05*	17.90	18.20	16.30	16.30	4.8	10.2	6.60	6.90
	(C. U.)	American negro or mulatto.	18.45	14.00	*75.88*	5.10	5.10	*26.56*	*27.13*	5.60	5.80	*29.16*	*30.85*	8.50	7.90	*44.27*	*42.02*	19.20	18.80	17.20	17.20	4.9	10.1	6.85	6.75
	(C. U.)	do	18.60	14.15	*76.07*	4.90	4.70	*26.13*	*25.07*	5.45	5.45	*29.07*	*29.07*	8.40	8.60	*44.80*	*45.87*	18.75	18.75	(?)	(?)	4.5	10.9	7.10	6.90
3022	(A. M. M.)	do	17.90	13.70	*76.54*	5.50	5.15	*30.89*	*28.61*	4.85	5.00	*27.24*	*27.70*	7.45	7.85	*41.85*	*43.61*	17.80	18.00	16.35	16.35	4.7	10.2	5.70	6.00
981	(A. M. M.)	do	18.40	14.10	*76.63*	5.45	4.90	*30.70*	*27.61*	5.00	5.00	*28.17*	*28.17*	7.30	7.85	*41.13*	*44.23*	17.75	17.75	16.25	16.55	4.5	10.2	6.10	6.00
222.126	(N. M.)	do	18.40	14.30	*78.14*	4.90	4.70	*27.61*	*26.93*	5.20	5.50	*29.29*	*31.16*	7.65	7.45	*43.09*	*42.21*	17.75	17.65	16.00	15.85	4.1	9.7	6.10	5.75
																				(13)	(13)	(15)	(14)	(15)	(15)
Average (14) [b]			18.6	13.9	*74.8*	5.12	5.00	*28.2*	*27.2*	5.34	5.35	*29.3*	*29.1*	7.73	8.02	*42.5*	*43.7*	18.19	18.38	16.68	16.82	4.8	10.2	6.29	6.39
Minimum 14			17.6	13.3	*71.9*	4.9	4.7	*26.1*	*25.1*	4.8	4.8	*27.2*	*26.6*	6.2	7.4	*37.4*	*41.6*	16.7	17.0	16.0	15.8	4.1	8.9	5.6	5.7
Maximum (14)			19.9	14.3	*78.1*	5.5	5.2	*30.9*	*28.6*	6.0	5.9	*32.3*	*31.2*	8.5	8.6	*44.8*	*45.9*	19.2	19.3	17.8	18.0	5.1	10.9	7.1	7.3

[a] Army Medical Museum; Transferred since to National Museum.

[b] Number of skulls in which all the fossæ could be measured.

Cranial fossæ (ventral). Adult females, negroes (African and American), dolicho- to mesocephals.

No.	Collection.	Nationality.	Skull.			Anterior fossa.				Middle fossa.				Posterior fossa, cerebral part.				Sum of the lengths of the fossæ.		Skull.		Foramen cecum to anterior border of pituitary fossa.	Breadth maximum of frontal region, ventrally.	Length of posterior fossa, cerebellar portion.	
			Diameter antero-posterior maximum.	Diameter lateral maximum.	Cephalic index.	Length.		Index.		Length.		Index.		Length.		Index.				Diameter antero-posterior maximum, ventrally.					
						Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.			Right.	Left.
			cm.	*cm.*		*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
1093x	(C. U.)	American negro.	18.40	13.20	*71.74*	(?)	4.85	(?)	*27.63*	5.30	5.50	(?)	*31.34*	7.30	7.20	(?)	*41.02*	(?)	17.55	16.40	16.40	4.4	10.1	5.50	5.30
27.5, 1894-95	(C. U.)	.....do.....	18.40	13.45	*73.10*	(?)	4.90	(?)	*27.14*	4.90	5.10	(?)	*28.25*	7.90	8.05	(?)	*44.59*	(?)	18.05	16.20	16.20	4.5	9.8	6.20	6.20
1802	(A.M.M.)	.....do.....	17.75	13.00	*73.24*	5.10	4.65	*30.00*	*27.27*	5.20	5.00	*30.59*	*29.32*	7.20	7.40	*42.35*	*43.40*	17.50	17.05	16.05	15.90	4.3	9.2	5.75	5.80
1109x	(C. U.)	.....do.....	17.70	13.20	*74.58*	4.90	4.75	*27.45*	*26.68*	5.35	5.35	*29.97*	*30.05*	7.60	7.70	*42.57*	*43.26*	17.85	17.80	15.95	15.75	4.6	9.5	6.15	6.00
1353x	(C. U.)	.....do.....	17.30	13.10	*75.72*	5.00	4.75	*29.41*	*27.69*	4.85	5.00	*28.53*	*29.15*	7.15	7.40	*42.06*	*43.15*	17.00	17.15	15.80	15.80	5.1	10.6	6.20	6.40
652	(C. U.)	.....do.....	17.95	13.65	*76.05*	5.20	(?)	*29.05*	(?)	4.70	(?)	*26.26*	(?)	8.00	7.85	*44.69*	(?)	17.90	(?)	16.45	16.35	4.8	9.6	6.20	5.90
16,2, 1898-99	(C. U.)	.....do.....	17.00	13.00	*76.47*	4.95	(?)	*28.45*	(?)	4.90	4.90	*28.16*	(?)	7.55	7.80	*43.39*	(?)	17.40	(?)	15.60	(?)	4.5	9.5	6.20	6.20
1349x	(C. U.)	.....do.....	17.85	13.90	*77.87*	5.15	5.15	*27.17*	*28.67*	4.70	4.80	*24.80*	*26.67*	8.10	8.05	*42.74*	*44.72*	17.95	18.00	(?)	(?)	4.5	9.3	6.45	6.20
1348x	(C. U.)	.....do.....	17.90	14.00	*78.21*	5.40	5.30	*31.12*	*29.94*	4.80	4.65	*27.67*	*26.27*	7.15	7.75	*41.21*	*43.79*	17.35	17.70	16.65	16.65	4.8	10.0	5.60	5.80
745	(C. U.)	.....do.....	17.00	13.45	*79.11*	(?)	5.10	(?)	*30.35*	5.10	5.00	(?)	*29.76*	7.00	6.70	(?)	*39.88*	(?)	16.80	(?)	(?)	4.6	9.7	5.75	5.65
Average (5) [a]			17.7	13.4	*75.9*	5.11	4.92	*29.1*	*28.0*	4.98	4.96	*28.4*	*28.3*	7.44	7.66	*42.4*	*43.7*	17.53	17.54	(8) 16.1	(7) 16.1	(10) 4.6	(10) 9.7	(10) 6.0	(10) 5.94
Minimum (5)			17.3	13.0	*73.2*	4.9	4.6	*27.2*	*26.7*	4.7	4.6	*24.8*	*26.3*	7.1	7.4	*41.2*	*43.1*	17.0	17.0	15.6	15.7	4.3	9.2	5.5	5.3
Maximum (5)			17.9	13.9	*78.2*	5.1	5.3	*31.1*	*29.9*	5.3	5.3	*30.6*	*30.0*	8.1	8.0	*42.7*	*44.7*	17.9	18.0	16.6	16.6	5.1	10.6	6.4	6.4

[a] Number of skulls in which all the fossæ could be measured.

Cranial fossæ (ventral). Fetuses and children, white, brachycephals.

No.	Collection.	Sex.	Length of body.		Skull.			Anterior fossa.				Middle fossa.				Posterior fossa, cerebral part.				Sum of the lengths of the fossæ.		Skull.		Breadth maximum of frontal region, ventrally.	Length of posterior fossa, cerebellar portion.	
								Length.		Index.		Length.		Index.		Length.		Index.				Diameter antero-posterior maximum, ventrally.					
			Breech-vertex.	Extended.	Diameter antero-posterior maximum.	Diameter lateral maximum.	Cephalic index.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.		Right.	Left.
			cm.	*cm.*	*cm.*	*cm.*		*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
224.843	National Museum.	Male	5.2	6.7	2.10	1.70	*80.95*	0.60	0.60	*33.33*	*33.33*	0.50	0.50	*27.78*	*27.78*	0.70	0.70	*38.89*	*38.89*	1.80	1.80	1.65	1.65	(?)	(?)	(?)
224.842	do	do	8.3	11.7	3.00	2.50	*83.33*	1.05	1.05	*31.82*	*33.33*	.95	.90	*28.79*	*28.57*	1.30	1.20	*39.39*	*38.10*	3.30	3.15	2.70	2.60	(?)	1.10	1.10
220.183	do	do	19.9	29.4	6.60	5.50	*83.33*	2.10	2.10	*29.57*	*29.57*	2.00	2.10	*28.17*	*29.57*	3.00	2.90	*42.26*	*40.86*	7.10	7.10	6.50	6.50	4.6	2.40	2.35
224.836	do	do	21.0	32.5	7.75	6.05	*78.06*	2.40	2.40	*28.74*	*29.09*	2.25	2.25	*26.94*	*27.27*	3.70	3.60	*44.32*	*43.64*	8.35	8.25	7.45	7.35	4.9	2.85	2.80
220.180	do	do	23.5	34.4	7.60	6.55	*86.18*	2.45	2.35	*29.88*	*28.48*	2.35	2.40	*28.66*	*29.09*	3.40	3.50	*41.46*	*42.43*	8.20	8.25	7.40	7.40	5.1	2.45	2.55
224.886	do	do	26.5	38.9	8.80	7.70	*87.50*	2.80	2.75	*29.78*	*29.25*	2.80	2.80	*29.78*	*29.78*	3.80	3.85	*40.44*	*40.97*	9.40	9.40	8.50	8.60	6.6	3.10	3.10
218.036	do	do	(?)	(?)	10.80	9.50	*87.96*	3.10	3.10	*27.43*	*27.43*	3.10	3.10	*27.43*	*27.43*	5.10	5.10	*45.13*	*45.13*	11.30	11.30	10.50	10.50	(?)	5.10	5.10
1106x	(C. U.)	do	(*a*)	(*a*)	16.70	14.30	*85.63*	5.25	5.05	*29.83*	*28.69*	5.40	5.50	*30.68*	*31.25*	6.95	7.05	*39.49*	*40.06*	17.60	17.60	(?)	(?)	(?)	5.65	5.90
224.860	National Museum.	Female	21.0	(?)	7.55	6.35	*84.11*	2.50	2.45	*33.56*	*33.11*	2.30	2.20	*30.87*	*29.73*	2.65	2.75	*35.57*	*37.16*	7.45	7.40	6.40	6.40	4.7	2.30	2.30
220.182	do	do	25.1	36.3	8.45	6.80	*80.47*	2.60	2.60	*29.71*	*29.38*	2.75	2.65	*31.43*	*29.94*	3.40	3.60	*38.86*	*40.68*	8.75	8.85	7.85	7.95	5.6	2.40	2.55
																						(9)	(9)	(6)	(9)	(9)
Average (10) *b*					7.93	6.69	*84.4*	2.48	2.44	*29.8*	*29.4*	2.44	2.44	*29.3*	*29.3*	3.40	3.42	*40.9*	*41.3*	8.32	8.31	6.55	6.55	5.2	3.04	3.08
Minimum (10)					2.1	1.7	*78.1*	.6	.6	*27.4*	*27.4*	.5	.5	*26.9*	*27.3*	.7	.7	*35.6*	*37.2*	1.8	1.8	1.6	1.6	4.6	1.1	1.1
Maximum (10)					16.7	14.3	*87.9*	5.2	5.0	*33.6*	*33.3*	5.4	5.5	*31.4*	*31.2*	6.9	7.0	*45.1*	*45.1*	17.6	17.6	10.5	10.5	6.6	5.6	5.9

a Child about 6 years old.

b Number of skulls in which all the fossæ could be measured.

Cranial fossæ (ventral). Fetuses and children, colored, brachycephals.

No.	Collection.	Sex.	Length of body.		Skull.			Anterior fossa.				Middle fossa.				Posterior fossa, cerebral part.				Sum of the lengths of the fossæ.		Skull.		Breadth maximum of frontal region, ventrally.	Length of posterior fossa, cerebellar portion.	
								Length.		Index.		Length.		Index.		Length.		Index.				Diameter antero-posterior maximum, ventrally.				
			Breech-vertex.	Extended.	Diameter antero-posterior maximum.	Diameter lateral maximum.	Cephalic index.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.			Right.	Left.
			cm.	*cm.*	*cm.*	*cm.*		*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
224.837	National Museum.	Male	17.6	27.0	6.25	5.10	*81.60*	2.15	2.10	*33.33*	*32.81*	1.95	1.95	*30.23*	*30.47*	2.35	2.35	*36.44*	*36.72*	6.45	6.40	5.75	5.75	4.2	1.70	1.70
224.851	do	do	23.7	(?)	10.20	8.40	*82.35*	3.35	3.25	*31.16*	*30.66*	2.90	2.90	*26.98*	*27.36*	4.50	4.45	*41.86*	*41.98*	10.75	10.60	9.90	9.90	6.3	3.40	3.30
224.855	do	do	30.8	45.0	10.20	8.50	*83.33*	3.20	3.20	*29.49*	*29.49*	2.90	2.90	*26.73*	*26.73*	4.75	4.75	*43.78*	*43.78*	10.85	10.85	9.60	9.60	7.1	3.60	3.50
224.854	do	do	35.9	52.7	10.50	8.90	*84.76*	3.50	3.30	*29.91*	*28.45*	3.10	3.00	*26.49*	*25.86*	5.10	5.30	*43.60*	*45.69*	11.70	11.60	10.50	10.40	7.1	3.75	3.75
224.857	do	do	36.4	50.6	10.90	9.00	*82.57*	3.00	3.00	*26.20*	*26.20*	3.25	3.35	*28.38*	*29.26*	5.20	5.10	*45.42*	*44.54*	11.45	11.45	10.50	10.40	7.0	4.25	4.15
224.853	do	Female	20.3	(?)	7.00	5.90	*84.29*	2.50	2.50	*33.33*	*32.47*	2.10	2.10	*28.00*	*27.27*	2.90	3.10	*38.67*	*40.26*	7.50	7.70	6.90	7.00	5.1	2.20	2.30
220.179	do	do	21.7	32.9	7.90	6.45	*81.65*	2.25	2.25	*26.78*	*26.78*	2.25	2.25	*26.78*	*26.78*	3.90	3.90	*46.44*	*46.44*	8.40	8.40	7.40	7.40	5.0	3.20	3.20
224.856	do	do	25.4	39.7	9.30	7.70	*82.80*	2.90	2.85	*29.14*	*29.23*	2.75	2.80	*27.64*	*28.73*	4.30	4.10	*43.23*	*42.05*	9.95	9.75	8.80	8.70	6.0	3.40	3.30
224.885	do	do	28.1	41.3	8.80	7.20	*82.95*	2.60	2.60	*29.38*	*29.21*	2.30	2.30	*25.99*	*25.84*	3.95	4.00	*44.63*	*44.95*	8.85	8.90	8.70	8.70	6.6	3.10	3.10
224.874	do	do	31.7	46.1	11.10	9.00	*81.08*	3.30	3.20	*28.69*	*28.07*	3.10	3.10	*26.96*	*27.19*	5.10	5.10	*44.35*	*44.74*	11.50	11.40	10.60	10.60	7.1	3.75	3.80
Average (10) [a]			.....	.....	9.21	7.62	*82.7*	2.87	2.82	*29.5*	*29.1*	2.60	2.66	*27.3*	*27.5*	4.20	4.21	*43.2*	*43.4*	.....	9.70	8.86	8.84	6.1	3.23	3.21
Minimum (10)			.....	.....	6.62	5.01	*81.1*	2.1	2.1	*26.2*	*26.2*	1.9	1.9	*26.0*	*25.8*	2.3	2.3	*36.4*	*36.7*	9.74	6.4	5.7	5.7	4.2	1.7	1.7
Maximum (10)			.....	.....	11.1	9.0	*84.7*	3.5	3.3	*33.3*	*32.8*	3.3	3.3	*30.2*	*30.5*	5.2	5.3	*45.4*	*46.4*	6.4 11.7	11.6	10.6	10.6	7.1	4.2	4.1

[a] Number of skulls in which all the fossæ could be measured.